POWER

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The Passing of the Boss

By Benjamin O. Wilkins

THIS is an age of rapid change. Things that have been familiar to us for years and customs that we have followed from youth are rapidly passing away. Among the old institutions that are now being numbered with the missing is the old-time boss.

The school of bossing is disappearing completely into the realm of the "things that were." We can scarcely realize, at times, that there ever was such an inefficient custom as "bossing" in current use. Yet such was the case; and most of us can remember the days when the head of the shop or office was not only called "the boss," but actually performed his function of supervising men by carrying out the idea of bossing to the limit. Not infrequently he did so with amazing genius for misunderstanding and with as little humor as the fellow that played the violin—"by main strength."

In the coming days of enlightenment and progress the man who is honored by being placed at the head of a group of men will realize that he is there to act as a helpful and stimulating influence. He will appreciate that he is given the position of trust and responsibility because he is judged by his ability to work *with* men rather than by the outworn and discredited standard that used to serve — the ability to make men work for him. He will be a coworker in the truest sense.

The most efficient leader nowadays is the man tnat is an inspiration and a guide to those who come to him for help. He is sought by the workmen because of his readiness and ability to furnish helpful information. Frequently, the worker feels the need of moral support in his tasks; so he goes to the man in whom he has faith and from whom he knows he will obtain the stimulus of encouragement.

From office, shop and factory comes the same report of the passing of the old régime — the boss is vanishing as an old-style dictator and is being supplanted by a new-style director. The successor is not afraid to put his hands to the work with his men, and his willingness to help lends encouragement and enthusiasm. The men are quick to sense his attitude and they respond by trying to save him petty annoyances and by showing a desire to do things more on their own initiative.

It is necessary that we adjust ourselves to such changes as these, which are for the benefit of us all. But to no one, perhaps, is the transition more difficult than to the old-time chief who is trying to conform to the new order. He needs our help and he deserves it.

The drivers of men have no place in the present industrial plan. The leaders of men have displaced them.

United States Nitrates Plant No. 2, Muscle Shoals, Ala.—Station Heat Balance

By EDWARD R. WELLES* and H. C. LOCKWOOD†

The hotwell water, which varies between 80 and 100 deg. F., is used for cooling the lubricating oil for the main turbine. This turbine is of 60,000 kw. continuous capacity and is electrically in parallel with two noncondensing house turbines which float on the line and furnish power for driving practically all auxiliaries in the station.

COMPETITION and the ever-increasing cost of labor and material have forced electric-power generating stations to utilize every available means to minimize their cost of power production. The two chief elements which form the basis of efficient power production are: First, station design and the arrangement of apparatus; and second, scientific operation and management. The latter is as important as the former, since poor operation may vitiate the natural advantages of the best-designed station. The design of the power house of United States Nitrate Plant No. 2 has been covered in previous articles. The purpose of this is to discuss and describe the operation of it.

With the accessibility of modern instruments and data, to attempt to operate any power-generating station without a complete detailed analysis of all station operations is the poorest policy. The steam generation of electric power is almost entirely a thermal process. The analysis of this flow of thermal energy in all its forms and functions from the coal pile to its final conversion into electric power is termed the station heat balance. By means of curves it shows the performance of all principal apparatus under all conditions and determines the most efficient points of operation. The heat balance also shows the expected and unavoidable losses in both position and extent and presents a criterion for all operation.

The following list of station apparatus has been considered in the heat balance:

1. Sixty thousand kw. unit, made up of three 20,000 kw. elements, consisting of a high-pressure element exhausting into two low-pressure elements, each of the latter being equipped with two 25,000-sq.ft. condensers.
2. Auxiliaries for 60,000-kw. unit consisting of four condensate pumps, four dry vacuum pumps, four circulating-water pumps, three blowers for generators, water pump for oil cooling, and excitation. Some of the pumps are, of course, spares.
3. Twelve 1508-hp. Stirling boilers.
4. Twelve underfeed stokers, with driving motors and forced-draft fans.
5. Boiler-feed pumps.
6. Two 2500-kv.-a. house turbines—noncondensing, with excitation.
7. Coal- and ash-handling machinery.

In general, the flow of thermal energy begins with the coal fired, which is its source. After conversion into steam, it drives all steam-driven apparatus, and finally is transformed into useful electric power. In this flow of energy there are numerous losses and two closed cycles of energy transfer. One of these closed cycles involves the energy returned to the boilers from the exhaust of all steam apparatus. This includes the condensate from the 60,000 kw. unit, the oil-cooling water and the exhaust from the house turbines and boiler-feed pumps. The other closed cycle is the power consumed by the boiler-feed pumps. This power is returned directly to the boilers in the form of pressure and kinetic energy. This cycle goes on continuously and, with the exception of slight frictional losses, there is no gain or loss, and hence the power delivered to the feed pumps has no effect on the heat balance.

The temperature of the hotwell water varies from 68 deg. to 100 deg. F., corresponding to the highest and lowest vacua, giving an average of about 80 deg. F. This is suitable for cooling the oil supplying the 60,000-kw. unit, and since a practically constant quantity of about 200,000 lb. per hour is required, which is heated to about 130 deg. F., a considerable heat saving is effected. A booster pump is necessary to raise the water pressure to get sufficient water through the oil coolers to produce the required cooling effect. This pump, however, consumes in power only about 1 per cent. of the amount of heat salvaged. Also, even if condensate were not used for oil cooling, an equal amount of water would have to be pumped by some other means.

Auxiliaries Mostly Electrically Driven

With the exception of the boiler-feed pumps, which, owing to their inherent operating characteristics, do not lend themselves well to electrical drive, all auxiliary apparatus is electrically driven. Power for this purpose is supplied by two so-called house turbines. The function of these turbines is twofold: First, to supply power for auxiliaries, and second, to supply exhaust steam for feed-water heating purposes. The auxiliaries could have been driven by power taken from the main bus, and steam could have been bled from the 60,000-kw. unit for the feed water; but the advantages accruing from the independence of power source and the avoidance of a possible shut-down because of motor trouble due to a jolt coming in from the main line made the house turbines advisable. The advantages of these turbines over individual turbine drive, are: First, they eliminate entirely the waste of surplus exhaust, for they may be set to furnish exactly the amount of exhaust steam required for feed-water heating under all operating conditions by adjusting their kilowatt output in accordance with the feed-water heating demands as indicated on the corresponding curves. It should be emphasized here that the controlling factor for house turbine operation is feed-water heating requirements and not auxiliary power requirements. Second, the house turbines afford the convenience of individual motor drives and eliminate a large amount of steam piping, and third, turbine speed reduction gears are entirely done away with, the reduction being accomplished electrically.

The house turbines are electrically connected through transformers with the 60,000-kw. unit in parallel and

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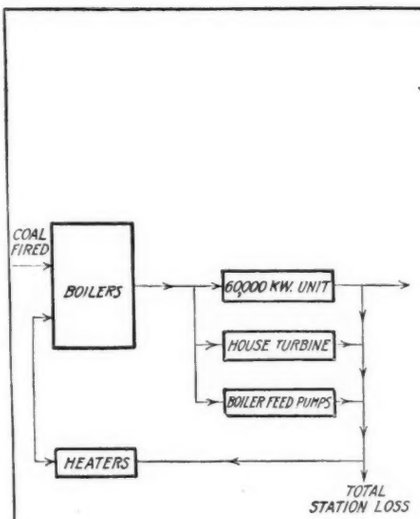
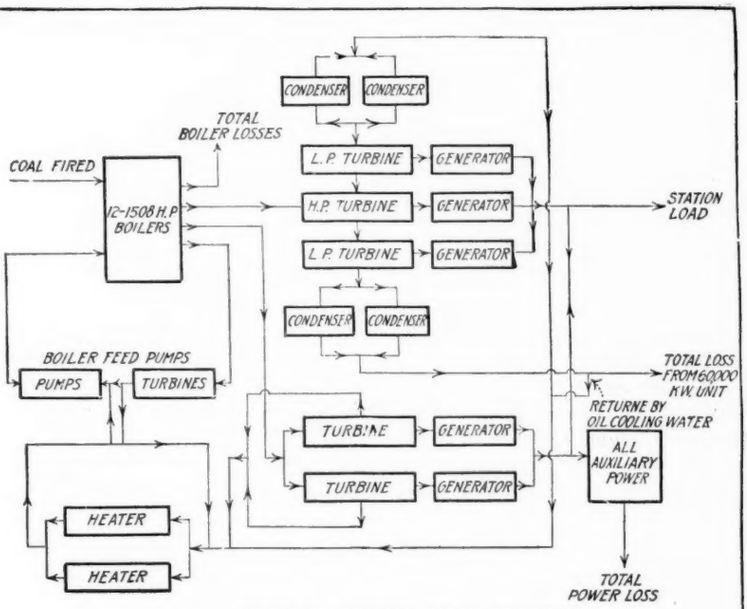
float on the line. They are set to furnish the required amount of exhaust steam necessary for feed-water heating purposes for any particular station load. If this loading exceeds the power demanded by the auxiliaries, which condition occurs at heavy loads, the excess is available for and may be credited to the station load. If the opposite condition prevails, as it does at light loads, the deficit is supplied by the main unit, and this power must accordingly be deducted from the station load. It is much more economical to take this power from the main unit than it is to load the house turbines to the necessary capacity and waste the surplus exhaust. The ratio of steam consumption for the production of equal amounts of power by the house turbines and the 60-000-kw. unit is approximately 25 to 11. Taking into consideration the thermal energy returned in the condensate from the main unit, it is thus about 2.4 times more expensive thermally to generate power by means of the house turbines when surplus exhaust must be sacrificed. However, on the other hand, up to the point of surplus exhaust, it is about three times more expensive to produce power for any purpose with the main unit. This is due to the fact that up to this point power is produced by the house turbines for practically nothing. Since all of the exhaust heat, including all latent heat, is returned to the system, the only losses are from radiation and friction.

From the foregoing it is evident that thermal efficiencies will be increased by raising the "surplus exhaust" point and obtaining all the power possible from the house turbines. This may be accomplished by increasing the back pressure, which will increase the amount of exhaust required for feed-water heating purposes, and, therefore, raise the "surplus exhaust" point. A limit to this procedure, however, is imposed by the fact that the steam consumption of the house turbines is not constant, but increases more and more rapidly with the back pressure, and also, in smaller measure, by the fact that the heat content of the exhaust becomes greater. A point is thus reached where the power obtainable from the house turbines, without surplus exhaust, begins to decrease as the back pressure is increased, even though more exhaust steam is called for. This point will, of course, vary somewhat with the station load, but is in all cases considerably in excess of 5 lb. The saving between 2½ lb. and 5 lb. back pressure amounts to about 1 per cent. at a station load of 50,000 kw. The percentage saving increases at light loads. Because of the fact that the turbine casings and the feed-water heaters are not designed to safely withstand a greater operating back pressure than 5 lb. and also because starting becomes more and more difficult with high back pressures, 5 lb. represents about the maximum.

Fig. 1 illustrates the flow of energy involved in the generation of power, as a whole. As will be seen, there is a closed cycle, a certain amount of energy being taken from and returned to the boilers. The two extractions from the system are the available station load and the total station losses, the sum of which must equal the coal fired.



STATION ENERGY FLOW IN GENERAL
FIG. 1



STATION ENERGY FLOW IN DETAIL
FIG. 2

Fig. 2 illustrates the foregoing in detail. Losses from radiation and friction have not been included.

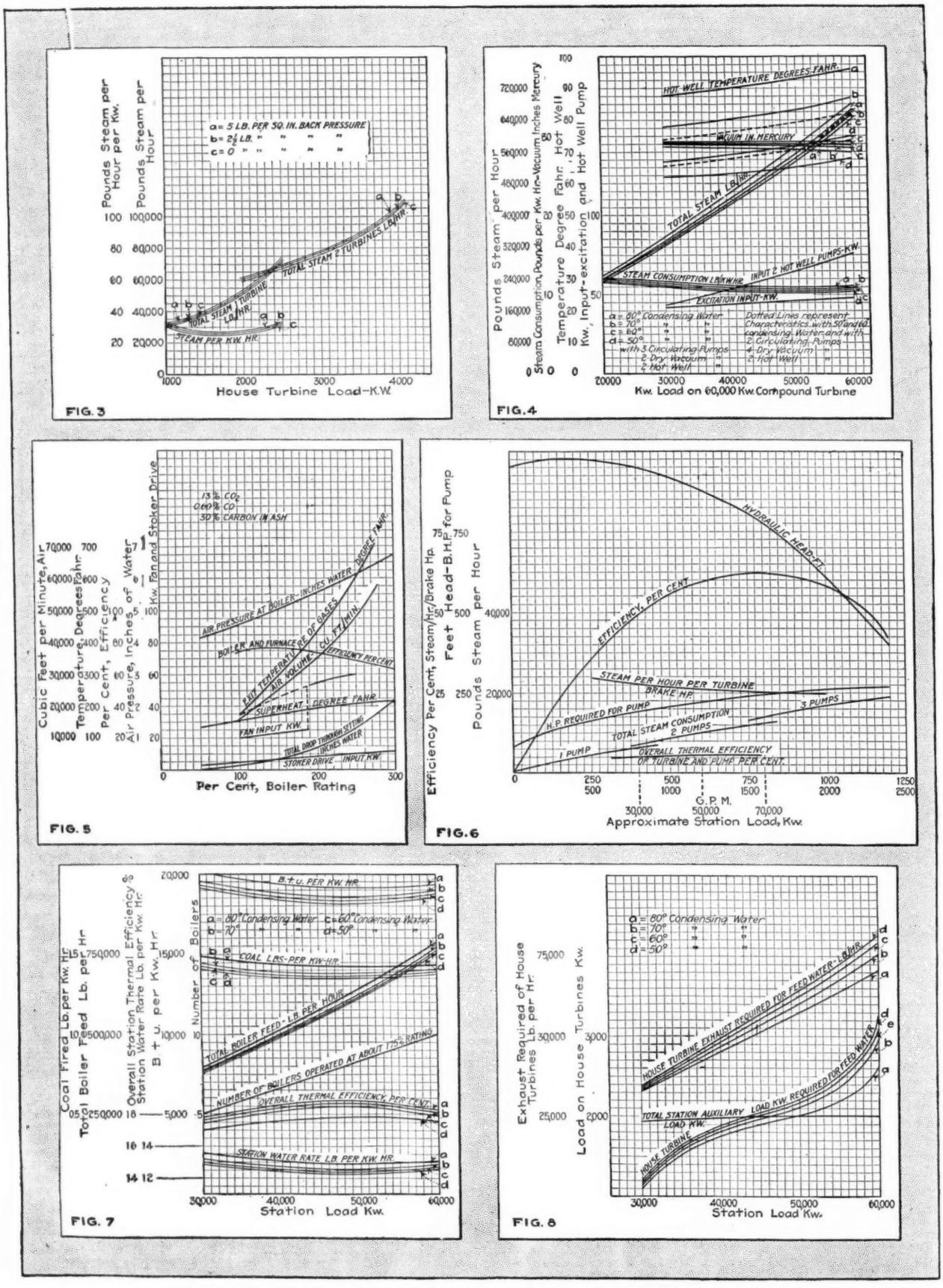
The expression for determining the quantity of exhaust, and hence the loading of the house turbines, for feed-water heating under various conditions is developed as follows:

A back pressure of 2½ lb. has been assumed.

An average steam consumption of 25.7 lb. per b.hp.-hour has been used for the boiler-feed pumps.

The average makeup-water temperature has been assumed to be 70 deg. F.

If c = Condensate from 60,000 kw. unit = lb. per hour.
o = Condensate from 60,000 kw. going through oil cooler,
n = Condensate from 60,000 kw. not going through oil cooler,
h = Exhaust from house turbines — lb. per hour.
f = Exhaust from boiler-feed pumps,


a = 5 LB. PER SQ. IN. BACK PRESSURE
b = 2½ LB. " " " "
c = 0 " " " " "
Pounds Steam per Hour per Kw.
Pounds Steam per Hour
TOTAL STEAM 2 TURBINES LB./HR.
TOTAL STEAM 1 TURBINE LB./HR.
STEAM PER KW. HR.
House Turbine Load-K.W.
FIG. 3
HOT WELL TEMPERATURE DEGREES FAHR.
VACUUM IN MERCURY
TOTAL STEAM LB./HR.
STEAM CONSUMPTION LB./K.W.HR.
INPUT 2 HOT WELL PUMPS-KW.
EXCITATION INPUT-KW.
Pounds Steam per Hour
Steam Consumption, Pounds per Kw. Hr.—Vacuum, Inches Mercury
Temperature Degree Fahr. Hot Well
Kw. Input-excitation and Hot Well Pump
a = 80° Condensing Water
b = 70° " "
c = 60° " "
d = 50° " "
with 3 Circulating Pumps
2 Dry Vacuum "
2 Hot Well "
Dotted Lines represent Characteristics with 50° and 60° condensing Water and with 2 Circulating Pumps
1 Dry Vacuum "
1 Hot Well "
Kw. Load on 60,000 Kw. Compound Turbine
FIG. 4
13% CO2
0.6% CO
30% CARBON IN ASH
AIR PRESSURE AT BOILER-INCHES WATER
BOILER AND FURNACE RISE OF GASES
AIR VOLUME-CU. FT./MIN.
EFFICIENCY PER CENT
EXIT TEMPERATURE OF GASES
SUPERHEAT-DEGREE FAHR.
FAN INPUT KW.
TOTAL DROP THROUGH SETTING-INCHES WATER
STOKER DRIVE-INPUT KW.
Cubic Feet per Minute, Air
Temperature Degrees Fahr.
Per Cent, Efficiency
Air Pressure, Inches of Water
Kw. Fan and Stoker Drive
Per Cent, Boiler Rating
FIG. 5
HYDRAULIC HEAD-FT.
EFFICIENCY, PER CENT
STEAM PER HOUR PER TURBINE BRAKE HP.
H.P. REQUIRED FOR PUMP
3 PUMPS
TOTAL STEAM CONSUMPTION 2 PUMPS
1 PUMP
OVERALL THERMAL EFFICIENCY OF TURBINE AND PUMP PER CENT.
Efficiency Per Cent, Steam/Hr./Brake Hp. for Pump
Feet Head-B.H.P.
Pounds Steam per Hour
G.P.M.
Approximate Station Load, Kw.
FIG. 6
B.t.u. PER KW. HR.
a = 80° Condensing Water c = 60° Condensing Water
b = 70° " " d = 50° " "
COAL LBS. PER KW-HR.
TOTAL BOILER FEED-LB. PER HOUR
NUMBER OF BOILERS OPERATED AT ABOUT 175% RATING
OVERALL THERMAL EFFICIENCY PER CENT.
STATION WATER RATE LB. PER KW. HR.
Coal Fired Lb. per Kw. Hr.
Total Boiler Feed Lb. per Hr.
Overall Station Thermal Efficiency %
Station Water Rate Lb. per Kw. Hr.
B. t. u. per Kw. Hr.
Number of Boilers
Station Load Kw.
FIG. 7
a = 80° Condensing Water
b = 70° " "
c = 60° " "
d = 50° " "
HOUSE TURBINE EXHAUST REQUIRED FOR FEED WATER-LB./HR.
TOTAL STATION AUXILIARY LOAD KW. REQUIRED FOR FEED WATER
LOAD KW.
HOUSE TURBINE
Exhaust Required of House Turbines Lb. per Hr.
Load on House Turbines Kw.
Station Load Kw.
FIG. 8

FIGS. 3 TO 8. GRAPHIC HEAT-BALANCE STUDIES OF U. S. NITRATE PLANT NO. 2

Fig. 3—Showing performance of house turbines under variable loading. Fig. 4—Performance data for the 60,000-kw. unit under different temperatures of circulating water. Fig. 5—Boiler and furnace characteristics. Fig. 6—Operating characteristics of boiler-feed pumps. Figs. 7 and 8—General station-operating characteristics and economies.

m = Makeup-water = 3 per cent. of above,
s = Total boiler feed = $(c + h + f + m)$,
T_h = Temperature of cold well, and
H_c = Total heat in condensate at heaters at $(T_h - 5)$, then

$$(o \times 100 + n \times H_c) + (h + f) \times 1153.1 + m \times 38 = 187.5 \times s$$

The boiler-feed pressure is about 325 lb., which is equivalent to 760 ft. of water; 60 per cent. is used for the pump efficiency. Then

$$f = \frac{760 \times 25.7}{500 \times 3960 \times 0.6} \times s = 0.0172(c + h)$$

substituting and solving

$$h = 0.179c - 20{,}300 - \frac{Hc(c - 200{,}000)}{984}$$

for 2½ lb. back pressure

Similarly

$$h = 0.187c - 20{,}500 - \frac{Hc(c - 200{,}000)}{977}$$

for 5 lb. back pressure

Solving for s,

$$s = 1.05(c + h)$$

The number of boilers is determined as follows:

Steam is taken at 285 lb. gage with 180 deg. F. superheat.

If H_s = Total heat in live steam,
H_f = Total heat in feed,
N = Number boilers operated at 175 per cent rating,

$$N = \frac{s(H_s - H_f)}{1.75 \times 33{,}479 \times 1508} = \frac{s}{78{,}500}$$

The number of boilers is determined by the foregoing and then the exact rating from

$$\textit{Per cent. rating} = 0.00224 \frac{s}{N}$$

The boilers will normally be operated at or in the neighborhood of 175 per cent. Throughout this range, as may be gathered from the characteristic curves of the boilers, the over-all boiler efficiency remains practically constant at 76 per cent. and the superheat at 180 deg. F. With coal averaging 13,500 B.t.u. per lb., which will for the present represent the average obtained, the coal fired per hour, in pounds, will be

$$\frac{s(H_s - H_f)}{13{,}500 \times 0.76} = 0.11 \times s$$

The total station auxiliary load which has been included in the heat balance is:

Constant part independent of station load: 3 circulating water pumps, 2 dry vacuum pumps, 3 blower fans for generators, oil-cooler pump.

Variable part dependent on station load: Stokers, forced-draft fans, 2 hotwell pumps, excitation for 60,000 kw. unit, excitation for house turbines, coal- and ash-handling machinery.

This auxiliary load consumes power and must be charged against the production of the ultimate product, which is the available station load at the switchboard. It thus affects the amount of coal fired and the quantities expressing station economies.

The curves of Fig. 3 represent the performance of the house turbines under variable loading. From these curves it is possible to obtain the necessary loading for any required amount of house-turbine exhaust. These values are plotted in Fig. 8. The most economical range of operation with 5 lb. back pressure is between 1600 and 1800 kw., with a steam consumption of about 26.5 lb. per kilowatt-hour.

Fig. 4 gives performance data for the 60,000-kw. unit under different temperatures of circulating water. The steam consumption, in pounds per kilowatt-hour is based on the actual amount of steam passing through the unit and the actual generated station load and does not include the steam consumed in the production of auxiliary power, which is taken care of by the total station water rate in Fig. 7. The lowest steam consumption is about 10.4 lb. per kw.-hr. and occurs at a load of about 500,000 kw., using 50-deg. injection water. The corresponding figure with 70-deg. injection, which represents average prevailing conditions, is about 10.8 lb. per kw.-hr. These are exceptionally low figures. The explanation is found in the economies due to the size and design of the 60,000-kw. unit and in the high heat content of the steam. Large units favor economy.

Fig. 5 shows the boiler and furnace characteristics. Two constant-speed squirrel-cage motors are employed for the forced-draft fan drive. The smaller one is entirely adequate for all ordinary loads, and the larger one is only used for occasional high overloads. The highest guaranteed boiler and furnace efficiency is about 77 per cent. occurring at about 140 per cent. It is hoped, however, that by virtue of the large combustion chamber and the fact that the entire boiler setting has been carefully and thoroughly insulated with a heat-insulating brick, and by close attention to operation, that the boiler efficiency may be bettered by possibly as much as 5 per cent.

Fig. 6 shows the operating characteristics of the boiler-feed pumps. The steam consumption is given for variable station load, making possible the determination of the amount of exhaust furnished by the feed pumps at any station load.

Figs. 7 and 8 illustrate the general station-operating characteristics and economies. The coal fired per kilowatt-hour attains a minimum of 1.35 lb. at a load of about 45,000 kw. with 50-deg. injection water. This is based on 13,500 B.t.u. coal; 14,000 B.t.u. coal would bring this figure down to 1.3. The corresponding minimum heat consumption is 18,200 B.t.u. per kw.-hr. The over-all station thermal efficiency reaches a maximum of 18.8 per cent. at about 50,000 kw., with 50-deg. F. injection water. It will be appreciated that these figures represent exceptionally high economies. Radiation losses have not been included in the computations, but these will be minimized by the heat insulation applied to all sources of such radiation. Blowdown losses and losses arising from careless handling (for example, coal), also have not been considered. But conservative figures have been used throughout, and it is expected that their betterment will at least offset the losses mentioned and that even higher economies will be obtained.

The total station auxiliary load is nearly constant between 30,000 and 60,000 kw.; the reason being that the major portion of this load is constant. The house-turbine load required for feed-water heating equals the station auxiliary load at about 45,000 kw. Below this point the deficit in auxiliary power must be made up by the main unit; above, the excess over auxiliary power is utilized for station load. The explanation of the discontinuity in the curves representing house-turbine loading lies in the fact that the first portion is for one machine, and the following portion for two machines. As will be noted, the point of inflection, or change, occurs at 2000 kw., which is the point at which a second machine must be started.

How To Build Low-Voltage Direct-Current Electromagnets and Solenoids

By HENRY W. TOWNSEND

Data on the construction of direct-current traction as well as solenoid types of magnets, for use on battery circuits, which have actually been built and tested.

THE design and construction of electromagnets for a given duty is not one of the easiest jobs, and this is so for many reasons. For one thing the grade of iron or steel used for the cores may vary, and unless an actual test is made of magnetic material's permeabality the finished magnet is quite likely to be off 10 or 15 per cent. from the calculated performance. Again, the coil or coils may not be constructed exactly to specifications and of course this introduces another error. Therefore, the appended data on a series of electromagnets, including solenoids, which have been built and tested, should be of service to electrical and mechanical men who frequently have a use for such apparatus.

A few instructions will be given in the discussion regarding the practical building and application of electromagnets, but the theory will be left out, as there are available plenty of textbooks dealing with the mathematics of electromagnet design.

The design shown in Fig. 1 is a double-pole electromagnet used on a polarized relay. It will prove very useful where one needs a relay for telephone and signal circuit. The principal dimensions are given in the figure. In all the magnets shown commercial wrought-iron bar, procurable at any machinery-supply shop, has

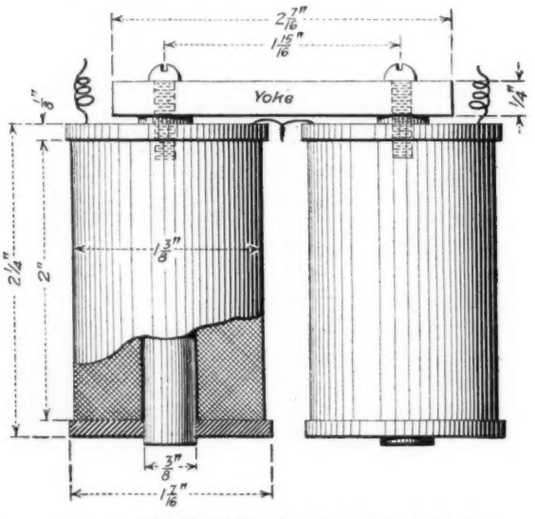


FIG. 1. DOUBLE-POLE ELECTROMAGNET

been found very satisfactory. For small magnets the rough outer coating of the iron may be turned off in a lathe, if desired, to make a better-finished and more accurate job.

Pay particular attention in every case to the "fit" made between cores and yoke. The abutting faces should be machined or filed very accurately, as the magnetic flux must pass through these joints without leakage or else the magnet will have a low efficiency; this is particularly true in the larger-sized magnets. Be careful to face off the pole faces square, particularly where an armature is used, as in Fig. 2. The armature should be of the same stock as the cores and yoke and of the same cross-section. That is, if the round core has one square inch area of cross-section, then the yoke and armature should have this cross-section also.

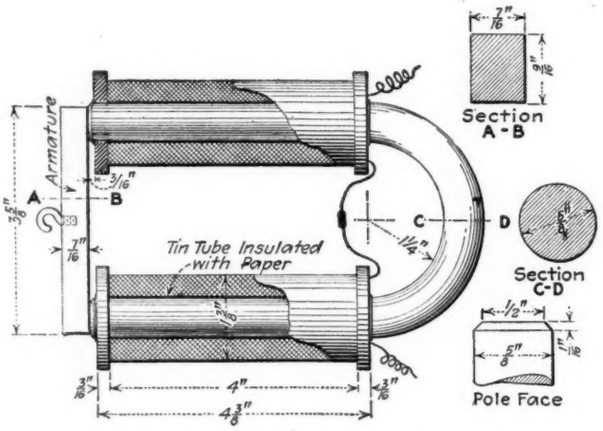


FIG. 2. HORSESHOE ELECTROMAGNET

In a small relay this is not always done, as the armature, to have the requisite delicacy of balance, may be smaller in cross-section than the cores, consequently the flux density through this part will be higher.

The bipolar (two pole) electromagnet of Fig. 1 may have fiber or hard-rubber ends on the coil spools. The core between the disks should be carefully covered with two layers of thin fiber or white note paper and may then be shellacked. Do not make the mistake of using a single fine wire lead from the coil; use a stranded lead (lamp cord is often used) or make one up of several pieces of No. 32 or 34 B. & S. bare or insulated wire and solder it to the fine wire comprising the magnet winding. Take two or three turns around the core with this flexible reinforced lead, and it will never pull out. A good method of forming both inside and outside terminals on small magnets is to use brass nails driven through holes in the fiber ends of the spool just small enough to make a driving fit; machine screws are also often used. In any event file them flat with the inside of the fiber face and solder the leads to them, and then place a small piece of silk or linen tape on the soldered joint.

To connect the coils in series the two inside or outside leads are joined together and the other two leads brought out for terminals. In a parallel connection the inside terminals of the coils are connected to the outside terminal and connection brought out from the junction point. Relay electromagnets are invariably connected up series, as the current in amperes required to actuate them is generally very small.

The coils for the design, Fig. 1, are wound in even

layers, either in a hand winder or in a lathe, with one of the following sizes of magnet wire, depending upon the resistance required. No. 40 B. & S. single-silk covered (s. s. c.), total resistance of two coils in series equals 15,000 ohms; No. 39 B. & S., s. s. c., total resistance equals 10,000 ohms; No. 38 B. & S., s. s. c., total resistance equals 5000 ohms; No. 37 B. & S., s. s. c., total resistance equals 3750 ohms; No. 34 B. & S. s. s. c., total resistance equals 937 ohms. One-half the foregoing values of resistance may be obtained by connecting the coils in parallel; the latter will be found most useful on signal circuits operated from battery voltages.

Be careful in connecting up the two coils, in series or parallel, to get the polarity correct. One pole must be a north and the other a south, in every case for all electromagnets of this typ

Designing a Battery Lifting Electromagnet

Fig. 2 shows the design of a battery lifting electromagnet. The core is made of one piece of soft-wrought iron—mild cold-rolled steel is often used as a substitute—bent in U-shape as indicated. The magnet bobbins are formed by placing fiber disks on sheet-tin tubes, permitting them to be wound on a wooden or other mandrel in the lathe. The tin tubes are soldered along the joints after the fiber end washers are in place. The ends of the tube are allowed to extend about one-eighth inch beyond the disks and slit, bent up and solder run around the upturned tabs, forming a substantial spool. Cover the tubes with two layers of thin fiber or paper, shellac them and wind on each spool 14 even layers of No. 22 B. & S. single cotton-covered magnet wire. Connect the coils in series to give resultant N and S poles, by compass test or by observing which way the windings run, as explained for Fig. 1. If the coils "buck" each other, the magnet will be very weak, hardly attracting a nail.

This little battery magnet is very handy for a wide variety of purposes, as, for instance, in picking up

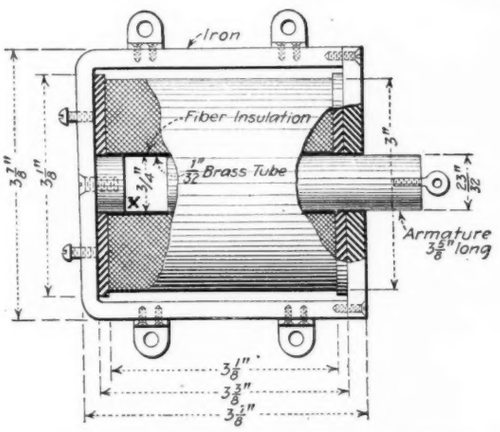


FIG. 3. SOLENOID-TYPE ELECTROMAGNET

screws and nails from stock bins and barrels. It will pick up several pounds of nails and screws at one time, and the windings can easily be changed to finer wire for use on 110-volt direct current.

On test this electromagnet, excited on 10 dry cells or 15 volts, took a current of 0.95 ampere and lifted 50 lb. The lifting power varies of course with the number of batteries used. For battery operation a storage battery gives the best result.

The design shown in Fig. 3 is for a solenoid type of electromagnet. In some experimental work it was found that the effective strength at different strokes could be about doubled by building a yoke of wrought iron or mild cold-rolled steel about it, so as to return the magnetic flux efficiently, instead of causing the flux to return from the N pole to the S pole through the air. The iron core carries the magnetism several

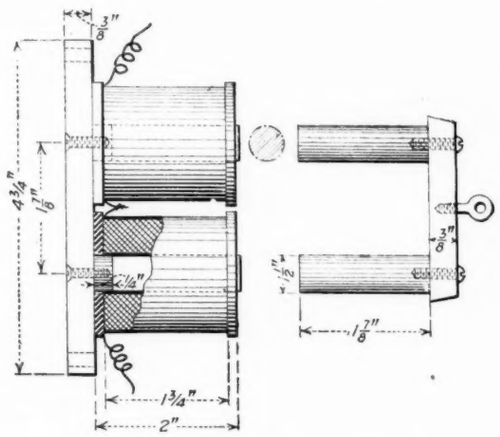


FIG. 4. DOUBLE-POLE SOLENOID

hundred times better than air, as any iron permeability table shows.

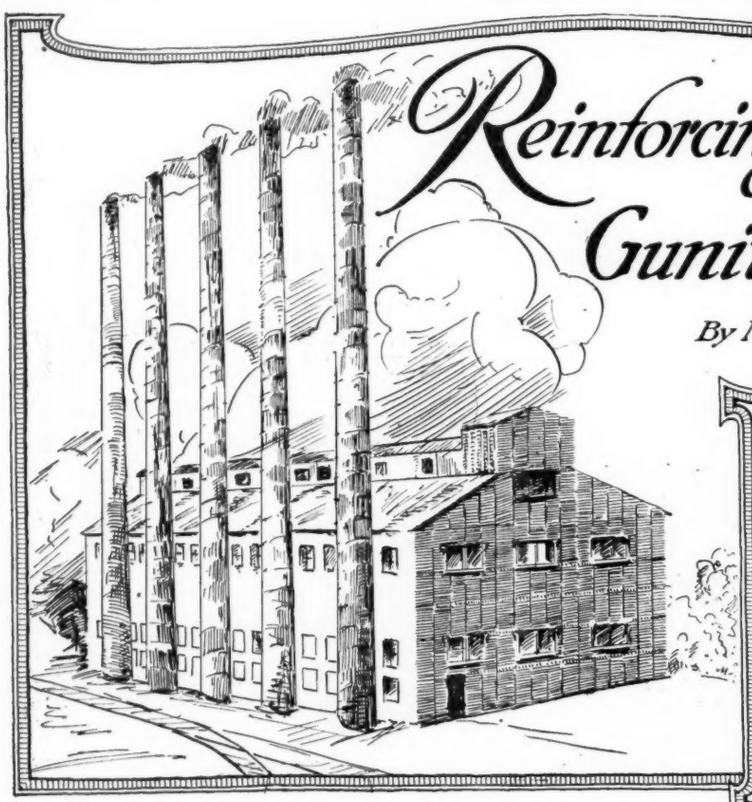
This solenoid is wound for excitation on 6 to 10 volts and was used with a storage battery in some experimental work. The spool and core dimensions are given in the figure. The bobbin is insulated with two layers of fiber or paper and then wound with 16 layers of No. 14 B. & S. enameled magnet wire. The current consumed on 6 volts was 6.67 amperes, the ampere-turns (product of ampere and turns) was 5000 and the coil's resistance equaled 0.9 ohm.; weight of magnet wire, 3¾ lb. The pull in pounds at various strokes, distance between end of core and the end x, when excited on 6 volts storage-battery current, was as follows: Stroke 1 in., pounds pull 10; stroke 1⅞ in., pounds pull 8.5

The pull of a solenoid is easily measured by a spring balance. Another good method is to attach to the core a pail which can be filled with sand. Sand is put in or removed, at each test on the core, until the solenoid can just pull it up. The pull is sometimes measured by means of a lever resting on a platform scale.

Double-Pole Battery Solenoid

In Fig. 4 is given the structural dimensions of a double-pole battery solenoid. Each coil is wound with twelve even layers of No. 18 B. & S. single cotton-covered magnet wire. The two coils are connected up in series to give north and south poles. All the iron parts are of annealed wrought-iron stock. The bobbin shells, which are made up on a brass tube, are tightly fitted, soldered or riveted if necessary, to the stop cores. The resistance of each coil measures 1.25 ohms and the current taken at 10 volts is 4 amperes. The pull obtained at various strokes, is: At 1 in., 1.25 lb.; at 1.5 in., 1.1 lb. At 12 volts and 4.8 amperes the solenoid gave a pull of 2 lb. at 1-in. stroke. The stroke of a solenoid is the distance the armature moves through in lifting its load.

A future article will deal with the construction of electromagnets and solenoids to operate on 110- and 220-volt circuits.



Reinforcing Steel Stacks with Gunite Concrete

By M. C. Sherman

Seven self-supporting steel smoke-stacks, each 125 feet high and six feet in diameter, became so badly corroded that it was necessary to rebuild them. This was accomplished by placing steel bands, vertical rods and wire mesh around the stacks. Then gunite was applied to the steel and wire-mesh work, making when completed, practically a reinforced-concrete stack.

AN INTERESTING job of chimney construction was completed recently by the Baker-Dunbar-Allen Co., of Cleveland, Ohio, on five pit-furnace stacks at the plant of the Pittsburgh Crucible Steel Co., Midland, Penn.

The original stacks, which were of self-supporting steel, 125 ft. high and approximately 6 ft. in diameter at the top, were badly corroded, owing to the gas from the furnace finding its way through the brick lining of the stacks and eating out the steel plate. The corrosion became so general that it was necessary to rebuild or repair the stacks. It was important, however, that they be kept in service.

The work was carried out by building reinforcing self-supporting shells around the stacks, and then employing the cement gun. Accordingly, all details were

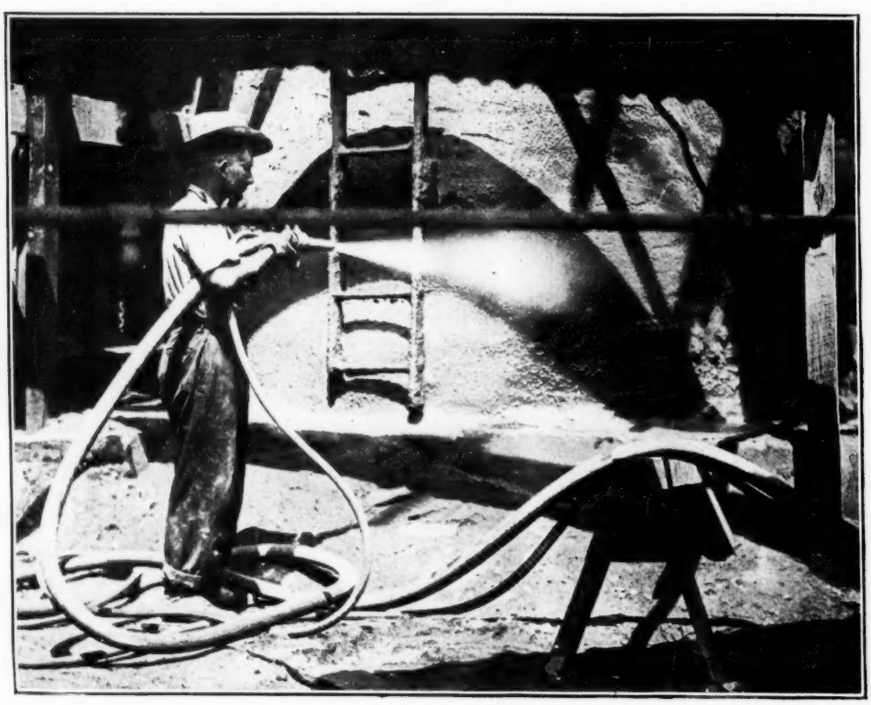


FIG. 1. APPLYING GUNITE MATERIAL TO THE BOTTOM OF A STACK

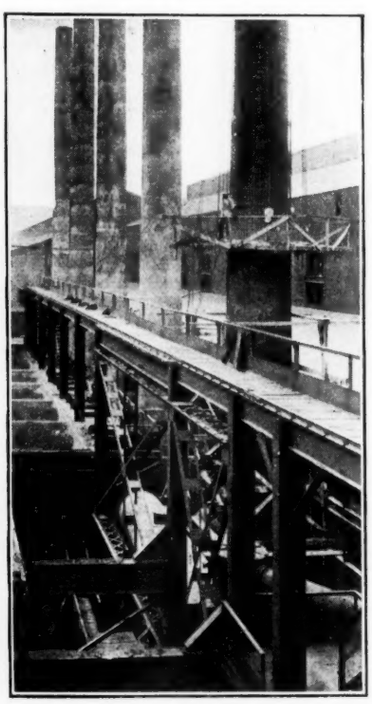


FIG. 2. FOUR STACKS COMPLETED

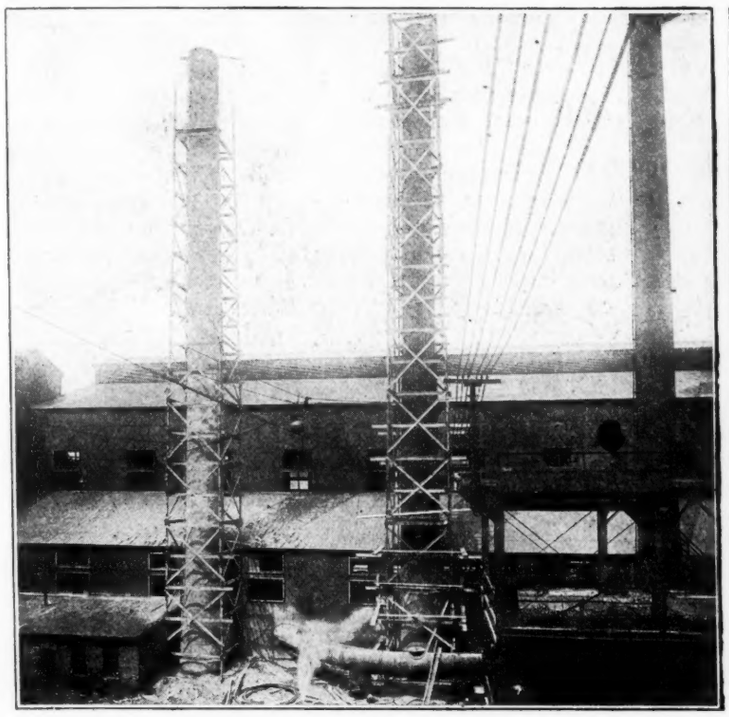


FIG. 3. ONE STACK COMPLETED AND SCAFFOLDING BEING REMOVED

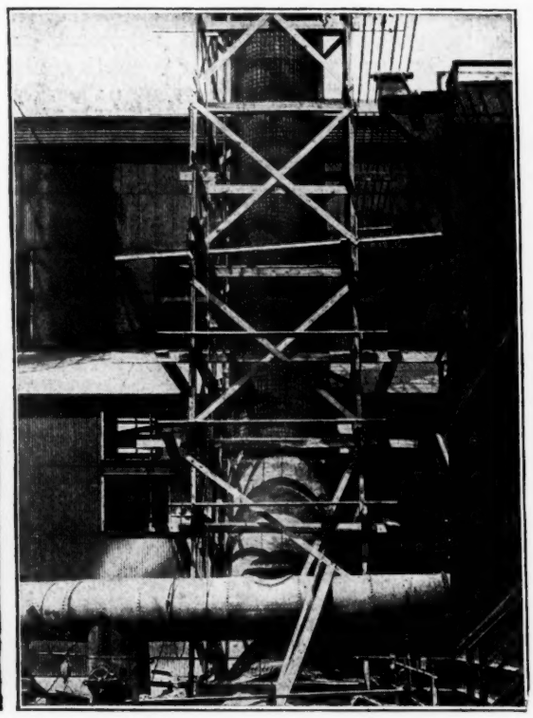


FIG. 4. CLOSE-UP VIEW OF ONE OF THE STACKS

worked out and the reinforcing cement envelope was applied. The new stacks have been in operation for over six months, and the construction has proved entirely satisfactory.

At each ring, bolts were tapped into the stack, these bolts carrying steel bands properly spaced, the bands in turn carrying vertical reinforcing rods of square twisted steel, around which was wrapped wire mesh. The gunite shells were applied against this reinforcement.

Each stack required approximately 1100 cu.ft. of finished gunite, which is reinforced with about 1½ per cent. of steel. After the completion of stack No. 2 it was thought that better results would be obtained by the use of swinging scaffolds of special design, instead of the continuous timber scaffolds. Accordingly the swinging scaffold was used on the last three stacks, with improved success over the timber scaffold that was first used.

Fig. 1 shows the nozzleman applying the material at the base of the stack. Fig. 3 shows stack No. 1 completed with the timber scaffolding in process of dismantling and stack No. 2 with the steelwork completed and the gunite at the base applied. Fig. 4 is a close-up view of stack No. 3, showing the nicety of steel-reinforcement work and applied gunite material. Fig. 2 shows four stacks completed and the fifth stack partly completed. Fig. 2 shows the swinging scaffold and Figs. 3 and 4 the timber scaffolds.

The finished work presented a somewhat splotched appearance, as shown in Fig. 2. This, however, disappeared as the gunite dried out. Special precautions were taken to keep the gunite moist until a full setting was obtained.

A great advantage in this method of building these stacks lies in the fact that they were kept in nearly constant operation during the progress of the work. Four of them were shut down for a few days while the gunite was being applied to the upper portions. One stack, however, was kept in constant operation while the work was being done.

The method of construction was less expensive than building forms around the present steel stacks and applying ordinary concrete. The speed of the work was also much greater; the operating force often applied 25 to 30 ft. of gunite, instead of the 5 or 10 ft. possible with the use of commonly used forms and ordinary concrete.

Undoubtedly, this gunite method (patent applied for) could be applied to a great many stacks that are in a poor state of repair, and it should be of particular interest to steel-mill operators, or anybody who has a self-supporting stack in need of repair and operating under conditions that make it inconvenient to cut it out of service, as the gunite as shown in the foregoing can be applied while the stack is in use as well as when it is idle.

Stationary Boiler Superheater

With the adoption of the steam turbine in power-plant practice, the use of superheated steam has become so common that practically no turbine plant is operated with saturated steam. By the use of superheated steam the efficiency of the turbine is increased through the elimination of losses due to friction in the nozzles and blades and the windage loss. The use of turbines has also led to increased steam pressure on larger boilers, which has necessitated a like growth in the size of superheaters and details of design have also kept step with the general progress of the modern power plant.

One of the latest entries into the superheater field for stationary power plants is the Locomotive Superheater Co., Woolworth Building, New York City. This company has recently brought out a new type of super-

heater for use in stationary plants, and the following points have been kept in mind in working out the design: Safety; accessibility for inspection and repairs; protection against overheating; high superheating efficiency; improved efficiency of combined boiler and

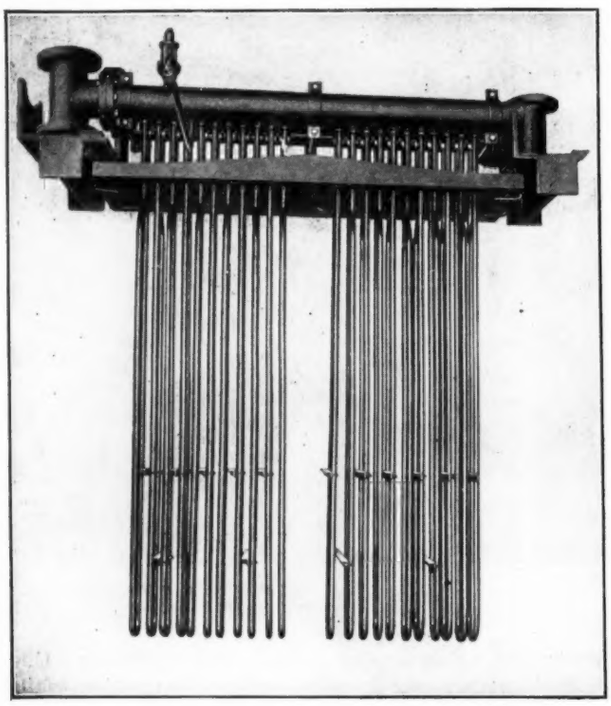


FIG. 1. SUPERHEATER HEADER ASSEMBLED

superheater; consideration of steam velocities and areas to provide minimum drop in steam pressure; uniformity of superheating and ease of regulation; provision for expansion and contraction; provision for cleaning; minimum possibilities for leaks; and flexibility and adaptation to many different designs of boilers manufactured.

As shown in Fig. 1, the superheater consists in general of two headers, one acting as the distributor for the saturated steam coming from the boiler and the other as a superheated header for the collection of the steam after it has been superheated, and the necessary connecting units in which the actual superheating takes place. The headers are of steel and are located outside of the hot-gas path, usually outside the boiler setting proper. In most cases the headers are made with the outlets on the superheated header in an opposite location to the inlet on the saturated header, and

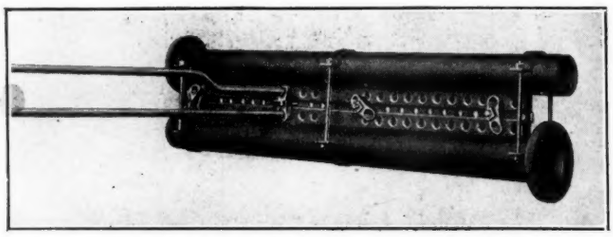


FIG. 2. HEADER SHOWING METHOD OF ATTACHING UNITS

where conditions require the saturated header is provided with several inlets.

The superheating units are of heavy cold-drawn seamless steel tubing, bent in such form as to provide freedom for expansion and contraction. They are connected to the headers by means of ball-and-socket joints with ground surfaces. The ball of the joint is forged on the end of the tube, and it is then faced and ground. It fits into a ground seat in the header, made at an angle of 45 deg. The ball and seat are held in close contact by means of clamps, bolts and washers. Fig. 2 shows a superheater header, showing methods of attaching the unit, and Fig. 3 shows the general construction of the superheater and illustrates several plans for installing it in vertical water-tube and return-tubular boilers.

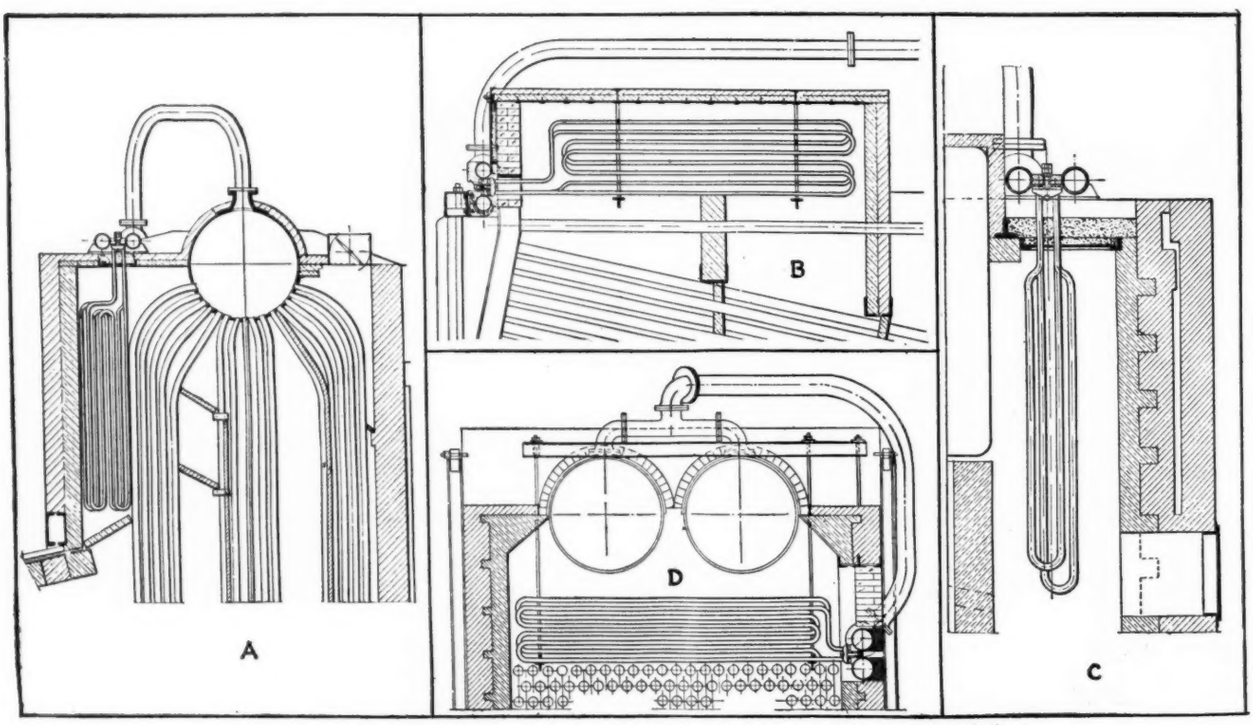
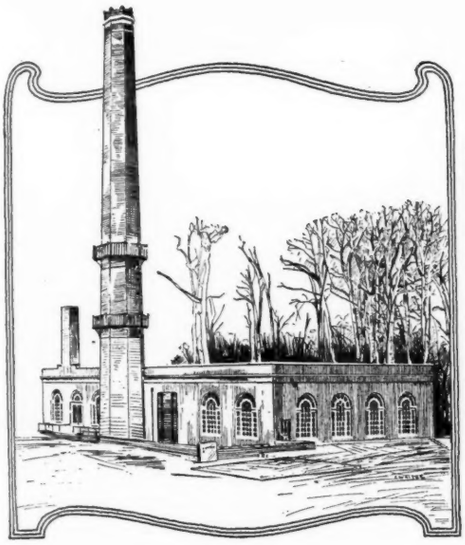


FIG. 3. SUPERHEATER AS APPLIED TO SEVERAL TYPES OF BOILERS

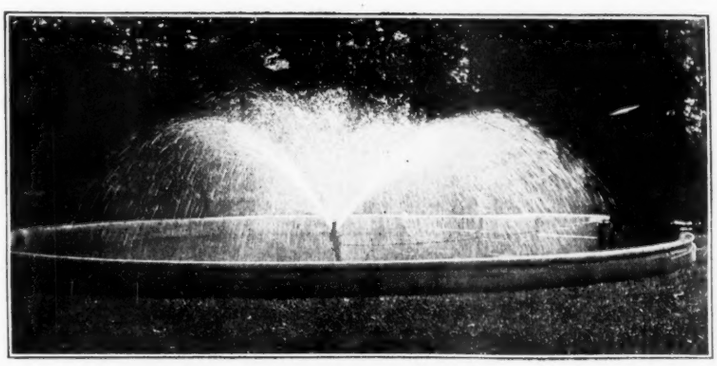


MECHANICAL EQUIPMENT *at* JOHNS HOPKINS UNIVERSITY

By Julian C. Smallwood

ORDINARILY, the mechanical equipment of a technical school falls in two distinct classes: First, that necessary for power, light and heat service; and second, that to be used for educational work only. It frequently happens, however, that educational results are improved by employing both of these classes; but as the service units are seldom arranged to suit the needs of laboratory students, much of the possible benefit is unrealized.

This is not the case with the engineering school of Johns Hopkins University. Naturally, the power plant is designed primarily with a view to providing economical and continuous service, which, of course, means the installation of modern engines and scientific instruments. But of nearly equal prominence is the purpose to include not only every usual facility for undergraduate experimentation, but also all practicable means for research, usual and special. In fact, it may be said that research is the keynote of the whole equipment.



SPRAY POND FOR COOLING CIRCULATING WATER

There are two power plants, the main one furnishing winter service through one of three steam units exhausting into the heating system, which may also receive reduced high-pressure steam. These three units consist of two turbine-generator sets and one four-valve reciprocating engine direct-connected to a generator. Any of these may be used for regular service or for student tests. There is an elaborate grid resistance installed in a separate room, with which an artificial load may be secured for the latter purpose.

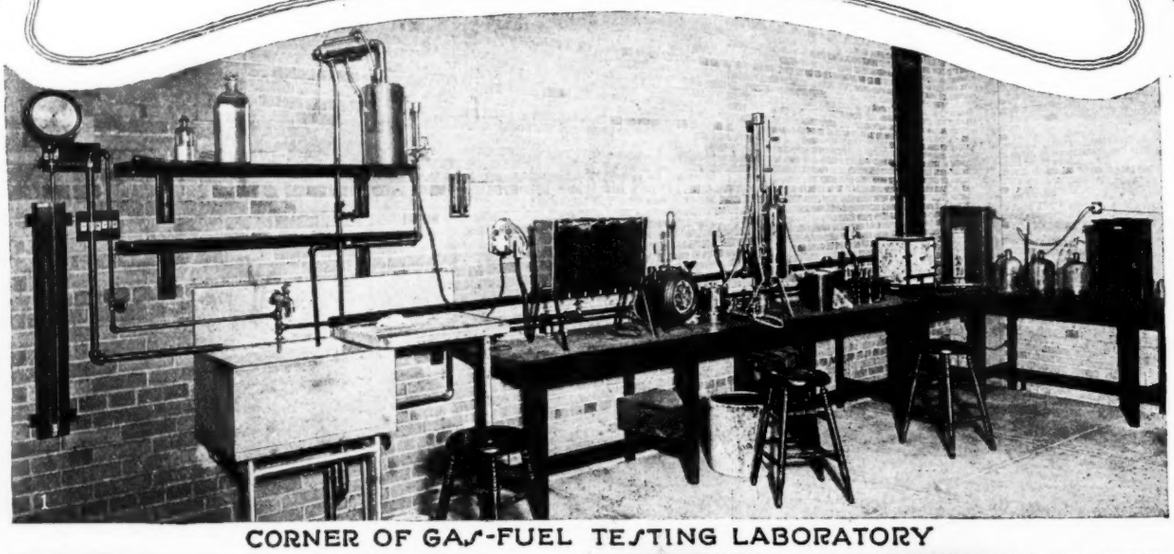
In the boiler room of the main power plant are four 250-hp. Babcock & Wilcox boilers, this large capacity being provided for future heating service. One pair is equipped with Roney and the other with Taylor stokers. Coal and ash are weighed when fired or removed, and the weights are recorded. The performance of the boiler room is at all times under observation through the autographic recording equipment, which includes a CO_2 recorder and a flue-gas thermometer not shown in the illustrations.

The vacuum heating system discharges its condensate into a receiver from which it is drawn by one of two feed pumps, and thence the feed passes through a closed feed-water heater and back to the boilers. Makeup water is provided automatically to the receiver. The boiler room almost runs itself, since the control is largely automatic as to both feed and draft.

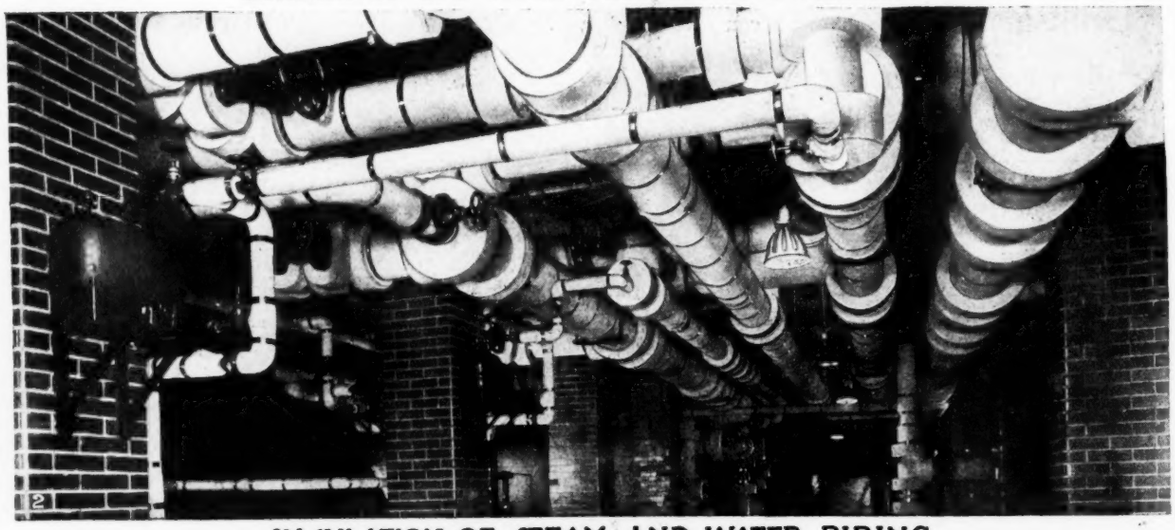
The second power plant referred to is a 50-kw. Locomobile of American design (Buckeye-mobile). This is in regular service during the warm months only, when there is no heating load, as it operates condensing. A surface condenser is used and the circulating water is cooled in a spray pond. The whole comprises an exceedingly economical unit as is evidenced by results of student tests—which, of course, fall short of professional operation—amounting to 2.26 lb. of coal per kilowatt-hour at rated load.

Supplementing both plants is a storage battery intended for night and Sunday lighting service. The saving in labor charge at the power plant during the periods when the battery is delivering current makes an ample return on the investment, besides having the indirect effect of making a higher load factor for the steam-power plant.

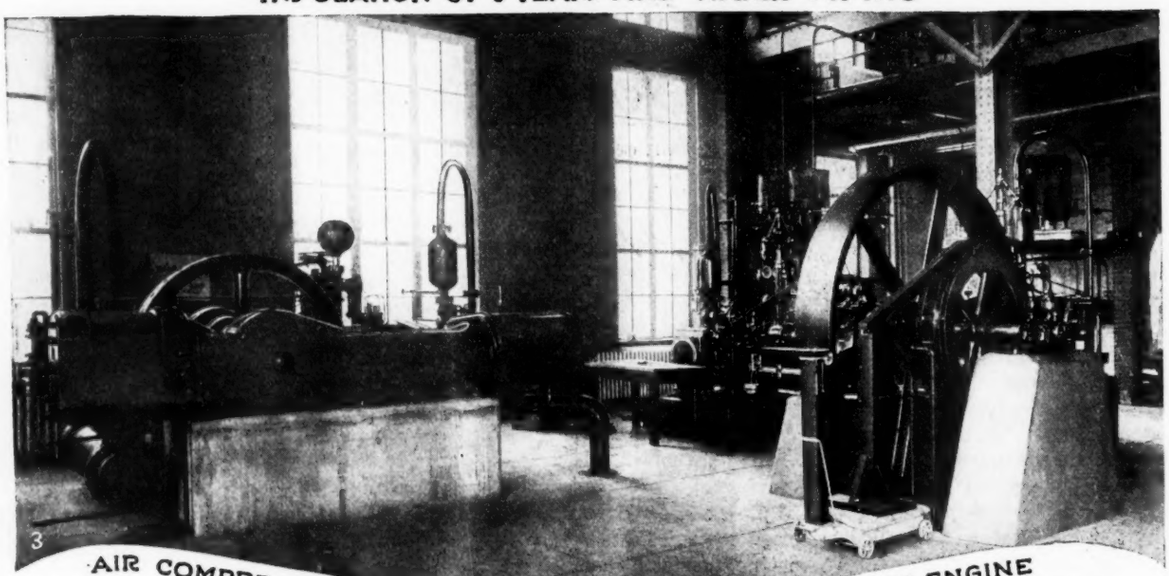
As regards testing equipment of all the service units, these are exceptionally complete in all the usual particulars, and in addition they have some very nice features of arrangement. For example, although the three main engine-room units, in regular operation, exhaust into the heating system, a surface condenser is provided into which any one of the three may exhaust for the purpose of steam-consumption trials. Two weighing tanks of 7000 lb. capacity are arranged to



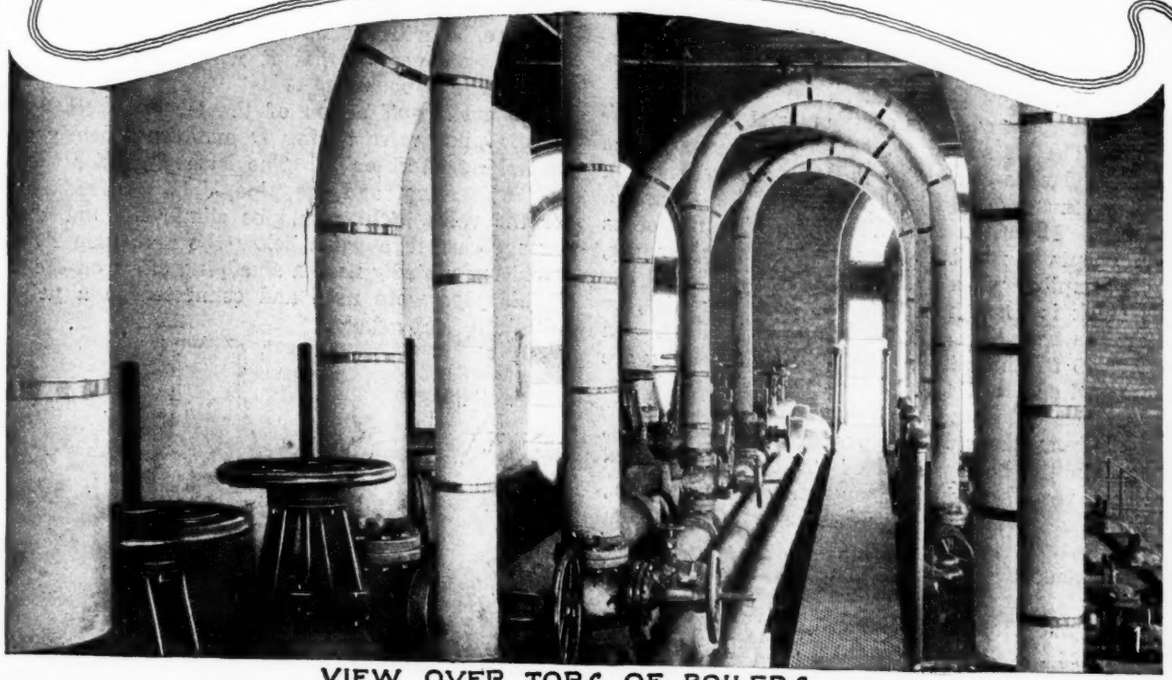
CORNER OF GAS-FUEL TESTING LABORATORY



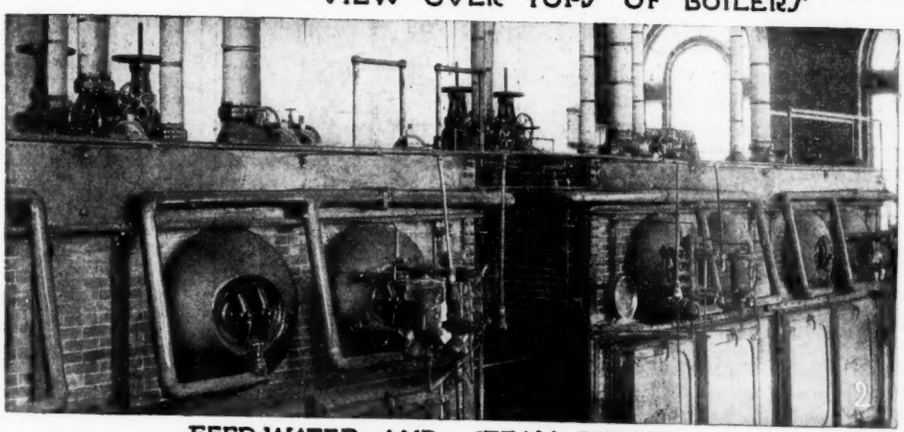
INSULATION OF STEAM AND WATER PIPING



AIR COMPRESSOR, REFRIGERATING MACHINE AND CORLISS ENGINE

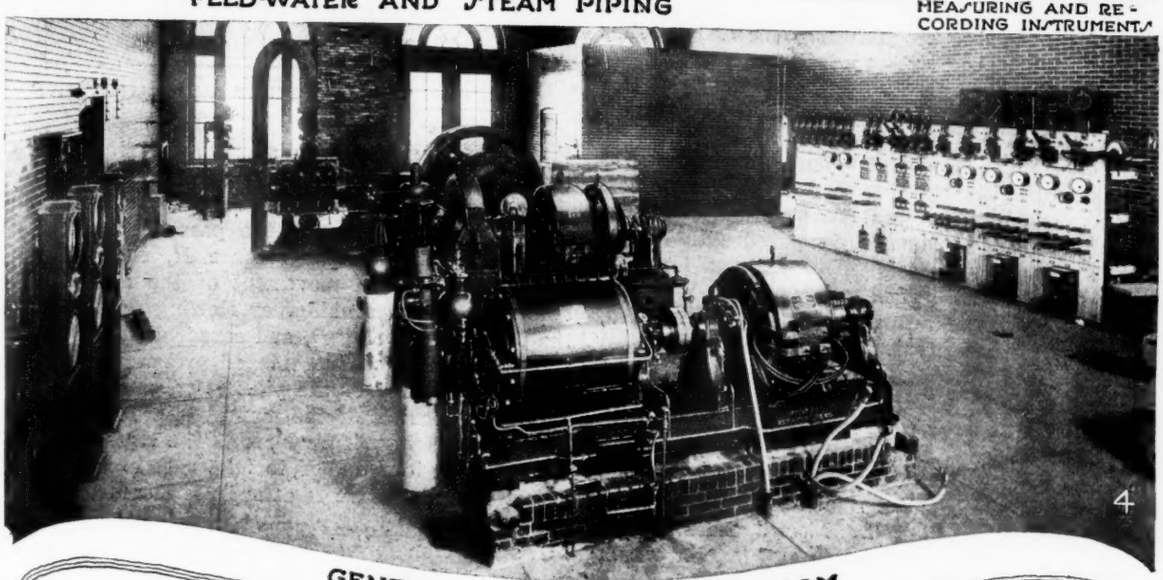


VIEW OVER TOPS OF BOILERS



FEED-WATER AND STEAM PIPING

MEASURING AND RECORDING INSTRUMENTS



GENERAL VIEW OF ENGINE ROOM

measure condensate, feed water to boilers or circulating water to spray pond. The last named is also supplied with a weir and V-notch recorder, recording thermometers, hygrometers, etc., by which very complete spray-nozzle tests may be made.

The boiler room contains some unusual facilities for research. The air supply to the Taylor stokers passes through a Thomas electric air meter, thereby enabling the measurement of the total amount of air during a boiler test. The settings of all boilers have numerous capped openings for the insertion of thermocouples, flue-gas sampling pipes or draft gages.

The stack is furnished with two iron balconies, or landings, as shown in the headpiece, one 50 ft. and the other 70 ft. above the grates. At each landing are eight capped openings for the insertion of draft tubes, thermocouples and pitot tubes. At the base of the stack, separated from the stack proper by a concrete floor just beneath the bottom level of the breeching, is an instrument room in which temperatures, drafts, etc., are read, these readings applying to various levels from the base up to the top. Some interesting experiments have been made with this equipment and will be continued.

The equipment provided strictly for experimental work includes the following: A 15-ton Frick refrigerating machine arranged to run dry or flooded, with calibrated tanks or weir measurement of brine and scales for ammonia weighing; an Ingersoll-Rand two-stage air compressor; several steam engines with the usual testing outfit; an 80-hp. Diesel engine with compensating prony brake; a Smith 25-hp. suction gas producer supplying a 14-hp. Nash gas engine; a Studebaker auto engine with fan brake; and various other small gas and gasoline engines. All of the more important internal-combustion engines are fully equipped for complete heat tests.

An unusually well-supplied laboratory is provided for fuel and gas testing, in addition to the instrument-calibration laboratory.

In a special building is a miniature illuminating-gas byproduct plant, erected and equipped for research.

Taken in its entirety, it may well be judged that here is an equipment fully calculated to maintain in mechanical engineering the traditions for which Johns Hopkins is known in other branches of science.

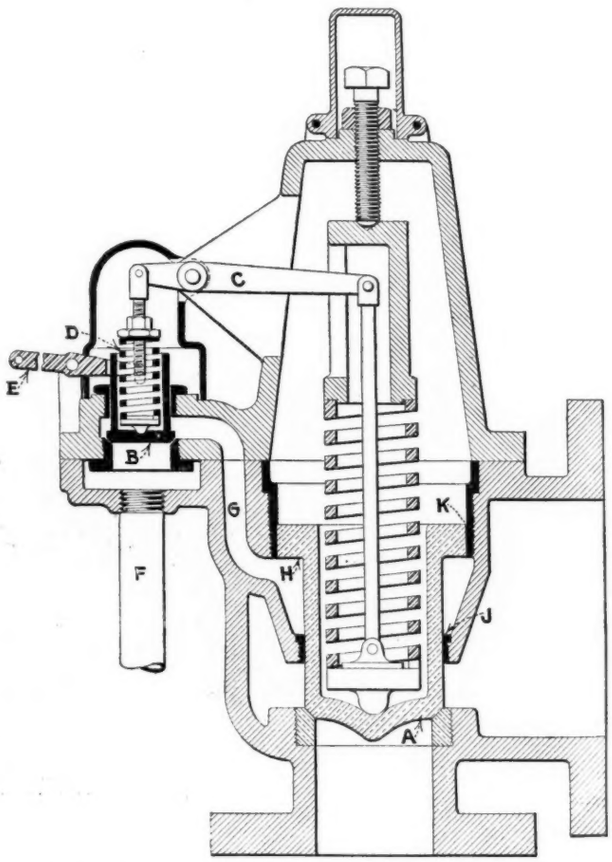
Full-Capacity Safety Valve

In the early days of steam boilers, when pressures were measured by atmospheres, and one or two atmospheres was considered a high pressure, and when the capacities of boilers were small compared with today's practice, a simple weighted valve, without lever or spring, was considered a good safety valve. With the increase in pressures and capacities came the weighted, or lever, type of safety valve.

A still further increase brought out the present spring-loaded valve, with which everybody having anything to do with steam is familiar. It would seem, however, that safety-valve capacity has not kept pace with boiler capacities, and the valve illustrated herewith has been designed as a solution of the problem. It is manufactured by Atwood & Morrill, Salem, Mass.

The valve is of the pilot-operated type, in which the main valve *A* is set at a somewhat higher pressure than the pilot valve *B*, and the movement of the main valve *A* has a direct cutting-off action on the pilot valve *B*. In other words, while this valve will open to full capacity where there is a continued increase of pressure, it will not do this at the first pop. This can be arranged so that it will extend over, say, a range of five pounds.

The cutting-off action of the lever *C* acts directly on the pilot valve spring *D* and consequently has a controlling effect on it. The lever *E* is for the purpose of testing, and the pipe *F* is the feeding pipe for the valve. This could be eliminated and a cored passage cast to a point below the main pop *A*, or it would undoubtedly have a steadying effect on the valve if this pipe were used and connected to a point in the steam drum at some distance away from where the safety valve is attached.



SECTION THROUGH PILOT AND MAIN VALVE

An upward movement of the pilot valve *B* allows a flow of steam through the passage *G*. This acts upward on the annular surface *H*, thereby opening the main valve. A movement of the main valve, as described, has a choking, or slowing down, effect on the pilot-valve spring *D*, and consequently on the pilot valve *B*. Continued increase of pressure at *B* means a greater opening of the pilot valve, and consequently a greater opening of the main valve *A* to the extent of a full opening, if required. The main valve *A* is loosely fitted to *J* and *K* to take care of steam which passes the pilot valve *B* after it is closed.

A static transformer of 60,000 kw. capacity has been made in Germany for stepping up from 6250 volts to 110,000 volts. An over-all efficiency of 99.07 per cent. is said to have been obtained.

Making Each Coil of Ammonia Condensers Do Its Share

By A. G. SOLOMON

An engineer of long experience in the operation of refrigerating plants tells how he manages to make each coil of ammonia condensers do its share in the all-important absorption of heat from the ammonia gas.

THE compressor is usually in good operating condition. Once a year it is given a careful overhauling, and the suction and discharge valves and the valve cages are ground in so that all joints are gas-tight. But within reason the working condition of the compressor is not as important as the condition and intelligent handling of the ammonia throughout its cycle.

The compressor has to take the heat-laden vapor from the evaporator and send it to the condenser. At a stated speed for a compressor of known dimensions a certain number of cubic feet of vapor will be compressed and delivered to the condenser in a given time. A not too badly leaking valve or a little groove in the compressor wall will lower this cubical displacement so little that it can hardly be detected on an indicator diagram. A slight increase in the clearance space will hardly be noticeable except by close and accurate figuring.

But the state of the vapor entering the compressor will make a difference that is readily apparent. So no matter how many cubic feet of vapor the compressor is able to displace, the objective which the engineer must strive for is to make every cubic foot carry as many heat units as possible from the evaporator and then to see to it that the greatest possible number of heat units are carried away by the circulating water at the condenser.

To make the whole refrigerating plant as efficient as possible, the amount of heat taken from the ammonia in the condenser is the main point to be kept in mind. Briefly stated, get all the heat possible out of the produce and into the ammonia, and then get this heat and the heat of compression out of the ammonia and into the circulating water. In the double-pipe ammonia condenser the water circulating through the inner tubes is the agent that performs this function.

Most engineers become concerned if the scale on the internal surfaces of the boilers gradually increases until the fuel consumption per ton of refrigeration shows an increase. But the same engineers do not always realize that they can gain in refrigerating duty by watching the condenser just a little more than has been their habit.

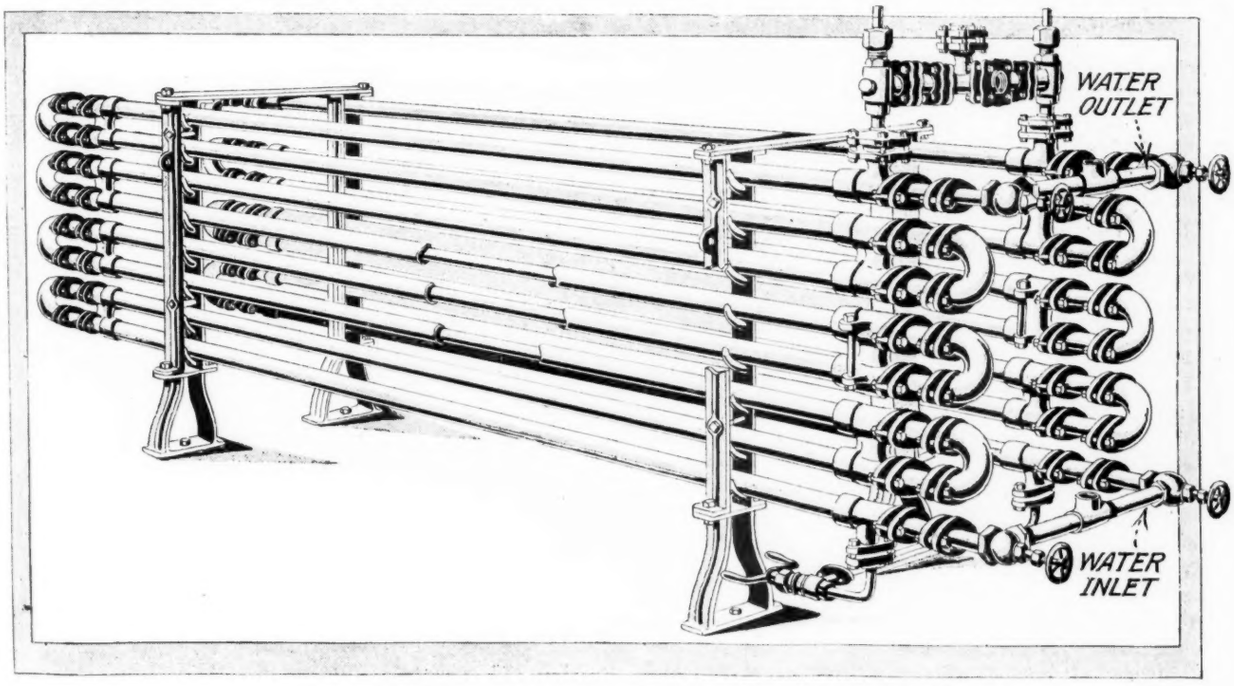


FIG. 1. SHOWING THE USUAL WATER-OUTLET CONNECTIONS

Let us see what is considered "a trip around the condensers" when the condenser happens to be of the single-pipe atmospheric type. The very first thing noticed is the way the water flows over the pipes of each stand. If one stand is not getting what is thought to be its share, the valve for that distributing trough or pipe is opened more. Or if the water is splashing considerably, owing to one stand getting too much, that valve will be closed a little.

If the water-regulating valves frequently become clogged this point is kept in mind and some one of the engine-room crew has a "trip around the condenser"

as part of his regular routine. Scale forming on the pipes of the condenser is prevented to some extent by washing them down with water having a good pressure behind it. And the scale is often hammered or scraped off the coils.

Most condensers of the double-pipe type receive little or no attention unless something happens. Some one of the engine-room crew will walk around this neglected condenser maybe once a day, and if he does not hear, see or smell ammonia escaping, all is well and good. In case of a leak the necessary repairs are made. The water circulation is scarcely given a thought.

In nearly all plants it becomes a regular habit to have the high-pressure gage show a certain number of pounds pressure on the condenser. Whether this is the pressure that should be carried is never questioned. Just so long as the pressure does not go up to a point that is thought to be too high, nothing is done to see if the condenser is working properly and liquefying the gas at the lowest pressure possible. And very few engineers know if each and every stand of the double-pipe condenser in his care is doing its full share of duty.

As this article is dealing only with the removal of heat units from the ammonia in the condenser, it will be taken for granted that the full amount of heat has been sent there for removal. First to be considered is the water circulation.

The writer has never had the pleasure of seeing the original water connections leading from a double-pipe condenser arranged in such manner that intelligent regulation could be maintained. Fig. 1 shows the usual practice. One can see at a glance that it is an utter impossibility to judge if the distribution of the water is proper for each coil.

The way this condenser is handled is at best a case of guesswork as far as the operator is concerned. The valves at both inlet and outlet of the inner tubes of every stand are wide open. This is true whether the condenser consists of three or of thirty stands. The only time that any of these valves are found partly closed is when there is an attempt made to economize on water, and at such times it is common practice to set every inlet or outlet valve the same. This may be one turn or three turns open; but whichever it is, they all get the same opening.

Imagine an engineer or boiler-room man setting all the water-feed valves the same on a battery of a half a dozen boilers. It wouldn't do. Neither will the setting of the water valves of the double-pipe condenser do if real efficiency is the object sought. Each boiler of a battery will not evaporate an equal amount of water, and there is just as much difference in the quantity of ammonia condensed in the different stands of an ammonia condenser.

Under changing operating conditions of the compressor there will be noticeable changes of the action of the condenser. We all know that at times one or more coils of a condenser will store full of liquid and the operating charge of ammonia will be reduced until the liquid is started circulating through the dead coil. When a coil stores ammonia in this manner it is easily located, as the whole stand will become as cold as the water entering the inner tubes. But when a coil only partly stores liquid or becomes what one terms slow or sluggish, it can continue in that condition for a long time without being noticed. If some of the coils are sluggish and deliver only a small amount of liquid to the receiver, some of the other coils will not condense their share of gas and the liquid that goes to the receiver from them will be warmer by several degrees than it should be.

To overcome many of the troubles found in double-pipe condensers, close watch of the water circulation is necessary. The drawing, Fig. 2, shows the water connections as they should be if the operator is to conveniently keep the condenser working efficiently. The inlet connections are the same as those in Fig. 1, but the outlet connections are different. By this arrangement the flow of the water through each coil can be watched, and, what is of greater importance, the temperature of the outgoing water can be taken at each coil.

It will be found that with all the water valves wide open there will be a temperature difference of as much as ten degrees at times between the outlet water of each of many different coils.

Let us suppose that the condensing water enters the bottom of the coils at 72 deg. In ordinary practice a rise of 7 deg. is maintained between the inlet and outlet

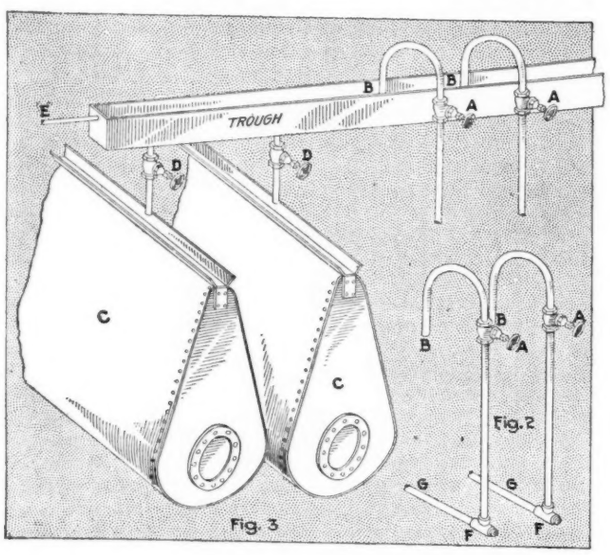


FIG. 2. SEPARATE WATER OUTLETS FOR EACH COIL

A, regulating valves; *B*, outlet where temperature is taken; *F*, tee with plug to facilitate cleaning; *G*, inner tube of top-pipe coil.

FIG. 3. TROUGH FOR WATER DISTRIBUTION OVER STEAM CONDENSERS

A and *B*, same as in Fig. 2; *C*, steam condensers; *D*, regulating valves (hand); *E*, overflow.

water when a coil is working satisfactorily. But all the coils will not show the same. For some reason some of them get more gas than others, and again some have a slower ammonia circulation. A coil that handles a large volume of gas will heat the water more than one that is not condensing so much.

Now if one coil becomes very sluggish or slow in circulation, the water from its outlet will be but one or two degrees warmer than the inlet. This sluggish coil will cause a shortage of ammonia, and the circulation of gas through another coil will be rapid, therefore liquefaction is often not complete. The water leaving the inner tube of this hard-working coil will be heated as much as ten or fifteen degrees and even more.

With the separate water outlet from each coil and valves to regulate the flow, it is possible to have every coil of a double-pipe ammonia condenser doing an equal amount of work. It will take some time and patience

before the regulation is satisfactory and the results noticeable; but when a real engineer is looking toward efficiency, he will be rewarded beyond his expectations.

At first temperature readings should be taken once every two hours; that is, the temperature of the outgoing water from each separate coil should be taken. If the water from one coil shows by its comparative coldness that too much water is being circulated for the work accomplished, the valve on that coil is closed a little. But do not expect to notice a difference during a few minutes or even a half-hour. Do not change the position of the valves oftener than once every two hours.

The best way to handle this temperature taking and water regulating is to have a card or suitable piece of paper tacked up close to the regulating valve of each coil. On this card mark down the temperature every two hours and also make a note as to what change is made in the position of the valve. In this way the valves will be handled intelligently and guesswork done away with.

After the proper flow of water through each coil has been found and the valves set, it will not be necessary to make further changes. The effect of this even temperature of the overflow water will be noticeable in the uniform liquid level in the liquid receiver. Also the regulation of the expansion valves will be easy as the temperature of the liquid will not vary.

In a distilled-water ice plant the separate outlet from each coil can be piped into a wooden or metal trough and the water for the steam condensers can be taken from this (see Fig. 3). The trough must be provided with an overflow so as to take care of any water that is not needed for the condensing of the steam. When a cooling tower is used, the outlets from the condenser coils are extended to the top of the tower.

Now that a method of water regulation is in use, the next step toward good results is free exchange of the heat from the ammonia to the water.

In another article the writer will deal with methods of cleaning the double-pipe ammonia condenser.

Rivesville, W. Va., New Power Plant

By J. W. Weir

Better electrical service for Fairmont and other towns served by the Monongahela Valley Traction Co. is being realized through the Rivesville, W. Va., power station, which is now in operation and is delivering energy to the lines and operating all of the car lines north of Jayenne, W. Va. In order to give better service the company has put the Rivesville station in operation before it is completed, and it will assist in carrying the load and at the same time add to its equipment until it has been completed and is ready to carry the load of the entire upper Monongahela Valley. At that time the Hutchinson plant, which has served the valley, will be kept in reserve so that in the development of the valley the traction company will be able to cope with the power situation.

The company's distributing lines from this station run as far north as Morgantown and as far east as Berryburg. A high-tension line is connected with the mines of the Maryland Coal Co., at Simpson and Galloway. They reach to Mannington and Baxter; a 66,000-volt line runs from the Rivesville station to the Hutchinson plant, and from that point power from the Rivesville plant is distributed over the lines that have been built into Hutchinson on to Worthington, Helens Run, Wyatt, Lumberport, through Clarksburg and on to Watson.

Some years ago the company built the Jayenne power plant. At that time it was thought that it would meet the demands for power for some time, but it was not long until it was outgrown. The Hutchinson power plant was then constructed and at the time this station was erected it was considered the best and most economical equipment that could be installed. The conditions at that time were right for the construction of that plant. Since its construction conditions have changed. What was then considered an inexhaustible gas field has been so depleted that the steam turbine plant is the more economical and especially so where the station may be supplied by coal mines within reasonable distance.

At the Rivesville station the main shaft of one of the company's mines is within sixty feet of the point where the coal is dumped into the hopper at the station to be carried by elevators to the stokers for the boilers. During the war period it was hard to get the needed repairs for the Hutchinson plant and in many instances the repairs that were secured were constructed out of inferior material. It was a case of the company doing the best that it could and all that it could to give its patrons the best possible service.

So the Rivesville station was built to take care of the rapidly increasing demand for electric power throughout, connections to it and to other mines in close proximity giving three sources for fuel.

The building is four stories high and is sufficient to house 50,000 kw., of which 20,000 is being installed. It is a fireproof steel frame and brick structure with steel window frames and gypsum roof.

The operating floor of the turbine room is 7 ft. above the 1885 flood and the boiler-room floor is 15 ft. above that mark.

An earth dike the top of which is 2 ft. above this highest flood mark will prevent water from running down the ash tracks into the boiler-room basement.

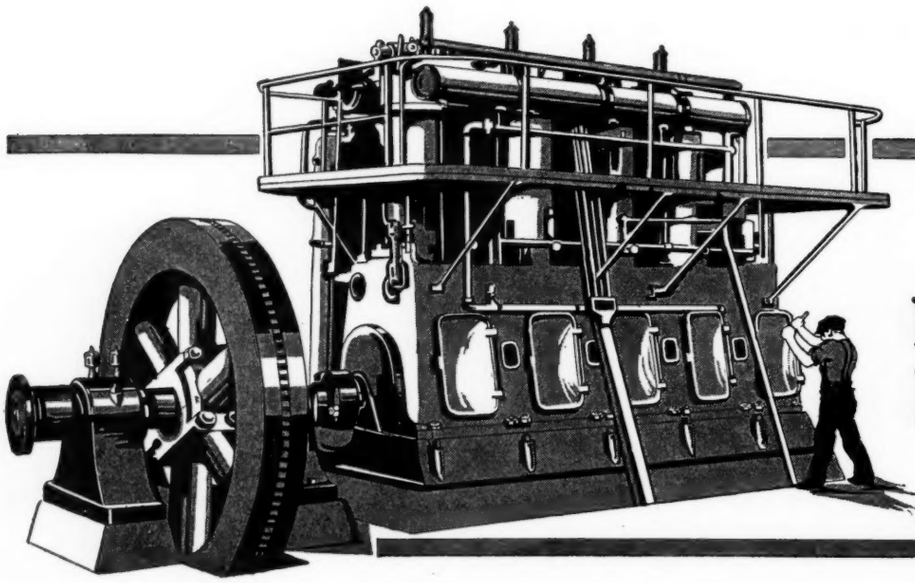
The boiler room is 115 x 150 ft., the turbine room 50 x 165 ft. and the switchhouse 27 x 165 ft. From the basement of the boiler house to the roof over the coal bunkers it is 108 ft. There is 20,000 cubic yards of concrete in the building, 1,500,000 bricks and 1500 tons of steel.

The boilers for the 20,000 kw. are four in number. Another will be completely installed within the next few days. They have a rated horsepower of 1245 each, and are of the horizontal cross-drum type. They operate at 250 lb. pressure and 250 deg. of superheat. They are fired by two underfeed mechanical stokers, one under each end of the boilers.

The coal is delivered from the mines on the property or from railroad cars into hoppers under the railroad tracks just outside of the building; from these hoppers it passes through crushers and by means of elevators and belts to the coal bunkers above the boilers. It feeds by gravity to traveling larries, which automatically weigh the coal and deliver it to the stokers.

Ashes are dumped into railroad cars which run underneath the boilers and are hauled away on the railroad or by trolley. All water used in these boilers is treated.

In the turbine room two 10,000-kw. turbo-generators are installed, with space for a 20,000- or a 30,000kw. machine. These units generate energy at 11,000 volts, which is stepped up at the outdoor substation to 22,000 and 66,000 volts for transmission to the various load centers.



Talks on DIESEL Engines

by L. H. Morrison

XVIII—Turning from details of construction and operating troubles, the men discuss the status of the Diesel engine and the outlook for engineers trained to run this type of engine.

THINGS had broken well all week, and so the crowd arrived at the meeting in a cheerful humor. "These are like old times," said Kelly, as he came in. "It used to be that we ran for weeks without a single breakdown and with the same old gang, too."

"Well," said Egan, "if conditions were the same we could do it again. In those days we had a 400-kw. load for an 800-kw. plant. We never ran at full load, for although we could have loaded one engine, our orders were to put on another unit when the running engine had more than three-quarters load."

"Why was that, J. R.?" Woods asked.

"In those days the oil engine was still regarded, at least in America, as a questionable source of power; so, to be safe, no one ever thought of having it pull full load. The operators were green and didn't know how to keep her up to the top notch. Really, a fellow was considered a born genius if he could keep her going twenty-four hours. At present I consider an engineer a poor one if he can't get practically full load for days at a time.

"In Europe, especially in Germany and Sweden, there are hundreds of plants, dependent on Diesel engines, that supply power to street railways, industrial factories and lighting systems. As much faith is put in them as we place in a steam plant. It is by no means uncommon in Germany to see plants containing 12,000 hp. in Diesels. In fact, units have been built of 6000 hp. each."

"I had the idea that we were as smart as the Huns," Kelly observed. "Probably smarter," retorted Egan. "In fact, smart enough to use whatever fuel nature supplied cheapest. So we stuck to our steam plants while coal was cheap. Now that it's high, more Diesels will go in. They will be successful, for each year scores of men are being trained as oil-engine men. One advantage Europe has on us is her ability to secure technically trained men as watch engineers. Because of low wages, it has been easy, in Germany, to employ a technical graduate for around $60 per month. While technical training is not absolutely essential, there is no doubt that an engineering education gives a man the capacity for thinking logically and correctly. In my opinion the fact that a man has finished an engineering course, either at college or night school, proves he is made of good stuff. He is the kind that has the ginger to do things and is dependable. Without reflecting on you fellows, it would be fine if all of you had had such a training. Then a lot of things that seem beyond explanation to you would be as simple as rolling off a log.

"However, I congratulate myself that the men at most of the plants are far above the ones we had four years ago. In those good old days, as Kelly calls them, about the only recommendation we got with a new man was that he couldn't read or write but was a natural-born engineer. If we had no trouble, it wasn't due to their work but to the old chief's energy and to the low load carried."

"Well, J. R., I can't see why a college man is the thing for a Diesel plant. I never saw many college graduates around steam plants," said Kelly, who was ready to defend his own lack of engineering education.

"I didn't say that they were more needed in a Diesel plant than in a steam plant. In past days, coal was cheap, and to be considered a good engineer or fireman it was necessary to have a strong back, even though accompanied by a weak mind. A man was rated by the tons of coal he could throw into the firebox. Keeping steam up was the order of the day, with no thought as to the cost of that steam. But now things are different. Just glance over the 'want' column and see the demand for technical men, both for the boiler house and the engine room. Nowadays it requires brains to successfully run a steam plant. A

At the next meeting Egan will answer some questions asked him on matters of interest to the men.

steam plant does have one advantage. The outfit will limp along even though boiler tubes leak and engine valves are out of shape. So most anyone can make the wheels turn even though at a frightful cost.

"In a Diesel-engine plant things are a little different. The fact that the engine will deliver its rated horsepower is good evidence that it is producing its power fairly economically. It may almost be taken as an axiom that a Diesel engine can't produce power uneconomically. I can also make the claim that the engine must be in good mechanical condition to run at all.

"These two statements, which our experience proves are facts, show why a poor engineer will have what he calls bad luck in operating a Diesel. If he is ignorant of the engine's peculiarities, when little things happen he is stumped, and the engine stops. The operator usually has no time to experiment to find out what's wrong. He must know immediately what remedy to apply. For this reason a better-trained and more intelligent operator is required than in case of a steam plant. If a man has had a technical education, he can reason more logically. His years of study have given him an insight into the theory of combustion and principles of mechanics.

"Unfortunately, the rate of pay in the average plant, both steam and oil, is not high enough to attract the college man in this country. Even though the matter of pay is brushed aside, the chance of advancement usually is meager. The day is coming, however, when this state of affairs will be changed. It's going to become an accepted fact that oil-engine operation demands brains, and trained ones at that.

"You men who have been denied the chance of an education have one advantage. Your years of work have given you considerable mechanical skill. To my mind, the operators, or at least one operator in each plant, should be a skilled machinist. With a Diesel plant there is much work requiring a higher degree of mechanical skill than in a steam plant. The clearances are less. It is necessary to have the bearings turned truer and made of better metal. The adjustment of governor parts, as well as fuel mechanism, demand the attention of a man who recognizes the importance of a thousandth of an inch. In the matter of bedding a valve to its seat, one cannot be satisfied with the finish cut that is usually given to a Corliss valve. On the contrary, the finished surfaces must be perfect; the ground seats should be as true as the surfaces of a telescope lens.

"In the near future, the ever-increasing sale of Diesel engines is going to create a demand for high-class engineers. A poor 'monkey-wrench and cold-chisel' engineer has no place in the Diesel engine room. This means greater opportunities and a higher value placed on your services. To meet this demand, you men should take up the study of mechanics and other engineering subjects. A correspondence-school course means hard labor after working hours, but if you ever hope to rise above the pay and rating of a watch engineer you must study."

"But hang it," Kelly broke in, "I don't think it requires a heap of knowledge to get along with a Diesel engine. Take the plant of the Gatesville Light Co. They are running that with a chief who was an automobile repair man, two engineers who never saw an oil engine a year ago, and two niggers. I don't see much book learning or even hoss sense in that crowd."

"I'm glad you mentioned that plant. It happens I have its record for last year. I also have the record of a Diesel plant, in an adjoining town, pulling the light and street-railway load. Now notice these figures:

	Gatesville	Other Plant
Pounds of oil per kw.-hr.	1.2	0.85
B.t.u. per kw.-hr.	18,870	15,725
Station load factor	0.50	0.85
Costs in mills per kw.-hr.:		
Labor	2.25	1.50
Fuel	4.50	3.20
Maintenance	5.00	0.05
Oil, waste, etc.	2.00	0.25
Total in mills per kw.-hr.	13.75	5.00
Station wages, monthly:		
Chief engineer	$100	$150
Watch engineers (2)	150	160
Oilers (2)	90	135
Total monthly labor expense	$340	$445

"Note the high fuel and maintenance cost of the plant using cheap labor. Some folks knowing the history of these plants might raise the point that the Gatesville engines are older and are not in good shape. This is true, but the fact they are not in good shape is due to the cheap labor that has run them ever since they left the factory. It is because of this labor that the load factor is so low. I've been in that plant at all hours of the day, and at no time was the load ever too large to be handled by one unit. Yet the inexperienced, poorly paid operators are afraid to put the load on one unit. So both engines are used to carry a one-engine load. The fuel costs are of course high, for the load factor is never more than 80 per cent. of a single engine's rating. The maintenance is high, since the units are run when they should be pulled out of service for a few hours. Instead of this, every Sunday is spent in useless repairing. I myself want intelligent and skilled help.

"You men should all subscribe to trade magazines. If each would take a different one, together you'd have most of the worth-while magazines published. By magazines I don't mean those published for the general public. In those, the attempt is made to write for the whole people, and of course the material is not very deep or accurate.

"Whenever you are near a power plant—steam, oil or gas—go visit it. You'll get lots of new pointers. Go over the plant and see where you'd change it—use your brains. In our own plant try to get at the reason for everything that happens. Ask questions. It's surprising how much you can learn from the other fellow.

"One class of men it will pay you to listen to with especial attention is the machinery salesmen, or, as they are called of late years, sales engineers. In the old days the usual machinery man dropped into the plant with a bottle in one hand and a cigar in the other. His stock in trade was his good humor and his shady stories. Of late years a new class of men are selling machinery. They know their business. I've gotten a lot of information from them. Lots of times their advice has kept me from making mistakes."

The use of big words is an old trick to inspire awe and respect. The label of a proprietary brand of clay poultice explains that this wonderful substance is "composed of the finest anhydrous and levigated argillaceous mineral," which expressed in language not "too good for the common people" would be simply "dried and finely powdered clay."

The Electrical Study Course—Testing Motor Efficiencies

Presents an outline of some of the methods commonly employed in the determination of motor efficiency. The brake test is then singled out for more detailed consideration.

THE lesson published in the issue of Dec. 24, 1918, described a method of testing the efficiency of motors without placing a load on them. As explained at the time, the method outlined does not give results of great accuracy. To determine the efficiency under the conditions actually obtaining when a motor is running under load, it is necessary to

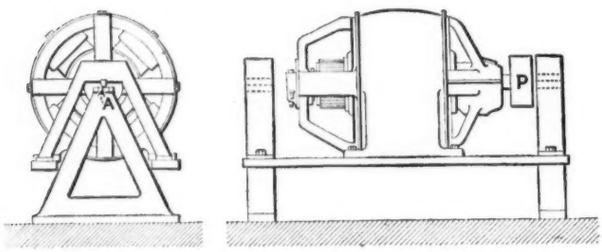


FIG. 1. DYNAMOMETER; GENERATOR FRAME SUSPENDED ON KNIFE-EDGES

employ a different form of test, in which the mechanical output of the machine can be obtained. There are several methods by which this can be accomplished. Thus, the motor may be coupled to a generator whose efficiency curve has been previously determined; since the generator output is equal to its voltage multiplied by the current it delivers, it is a readily obtainable quantity, and since the efficiency at that load can be found from the efficiency curve, its power input can be computed. This input, being derived entirely from the motor, is therefore the mechanical output of that machine, which is consequently determined.

Another method of measuring the efficiency is to measure the output by means of some type of dynamometer, a favorite form of which is a generator whose field frame is supported in such a manner that it is free to move concentrically about the armature as, for example, in the manner illustrated in Figs. 1 and 2. In the former the frame is suspended upon knife-edges *A* and in the latter by means of the bearings *B*.

The motor to be tested is belted to the pulley *P*, Figs. 1 and 2, in either case, causing the dynamometer machine to run as a generator. By varying the load connected to the generator the load upon the motor can be controlled. When current flows through the generator armature, it exerts a drag on the frame since its conductors are forced to cut through the magnetic flux of the field, and the degree of drag depends upon the amount of current. This drag tends to make the frame revolve, and by measuring the force required to keep it from doing so, the power transmitted to the dynamometer by the motor can be computed.

The figures are to be considered as merely representing the theory of operation and not as actual illustrations of the apparatus used. These types are known as transmission dynamometers, since they transmit the energy without expending it within themselves, barring, of course, the amount used in overcoming the losses in the dynamometer machine. That is, the energy of the motor is really used up in the lamps or other load that may be supplied with current from the generator. There are other types of transmission dynamometers, but they all have for their object the transmission, without absorption, of energy, coupled with means for determining the amount of power transmitted.

In contradistinction to the transmission type there is a class in which the energy output of the motor is entirely absorbed within the dynamometer. This type is nothing more or less than a brake that is applied to the pulley of the motor. That is, a brake test is made upon the motor as it would be in the case of an engine, for instance. In addition to the various methods mentioned in the foregoing, there are others that can be utilized when two like machines are available. In these one of the machines is operated as a motor and the other as a generator. They are connected electrically and mechanically, the arrangement being such that either the generator furnishes the current necessary to run the motor, or the motor furnishes the power necessary to drive the generator. The losses in the two machines are supplied either mechanically by a third motor of small size, or electrically from the supply mains. In either case the electrical output of one machine and the electrical input of the other are known, since they can be measured by means of voltmeters and ammeters. From these data and a knowledge of the losses, which are determinable, the efficiency of the machines can be computed. Of all the methods described, the one that adapts itself most readily for use under any circumstances is the brake test, and a more comprehensive explanation of it will be given than has been undertaken for any of the others.

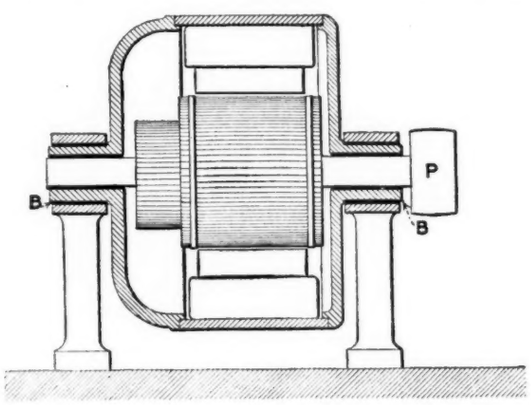


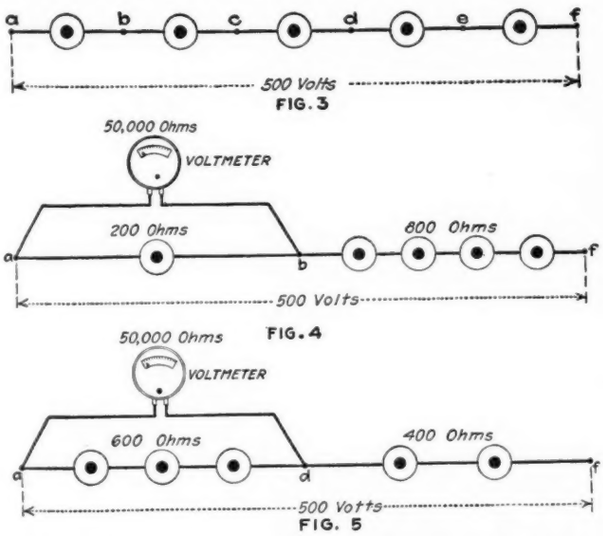
FIG. 2. DYNAMOMETER; GENERATOR FRAME SUPPORTED IN BEARINGS

To begin with, the object of any such test is to measure the mechanical output of the motor at the same time that the electrical input is measured, in order that its efficiency at the load it happens to be carrying can be calculated. Thus, if P represents the power output, P_1 the power input, and E_f the per cent. efficiency, we have $E_f = \frac{P}{P_1} \times 100$. If we let E repre-

sent the voltage at the motor and I the current taken by it, we have, the power input $P_1 = EI$, and consequently $E_f = \frac{P}{EI} \times 100$. The values of E and I can readily be determined by means of a voltmeter and an ammeter connected into the circuit. It therefore remains to find P.

Since the efficiency at various loads is to be determined, it is necessary not only that P should be capable of being computed, but that the adjustment of the load that gives rise to P should be under control. By applying an adjustable brake to the pulley of the motor this object can be accomplished. Before describing the types of brake commonly used, and the methods provided to obtain the observations required for calculating the motor output, some attention should be given to the construction of the pulley to be used.

When it is considered that the entire output of the motor is going to be consumed in friction between its pulley and a brake, it becomes evident that a great deal of heat is going to be generated, which will of course heat the pulley. If no provision is made to cool the pulley, it can readily reach a temperature that will scorch, and even ignite, the brake. At the same time much of the heat would be transmitted through the shaft to the bearing and to the armature, resulting in injury to the machine. It is therefore necessary to provide means for limiting the temperature of the pulley to a safe value. It is, moreover, desirable to maintain as constant a temperature as possible, as it will be found that the friction between the pulley and the brake varies with the temperature, making it a



FIGS. 3 TO 5. FIVE LAMPS CONNECTED IN SERIES

matter of difficulty to keep a constant load on the machine when its pulley temperature is allowed to vary greatly.

The details of the pulley construction and of the brake will be taken up in the lesson of next week.

The problem of the preceding lesson related to the voltages across five 50-watt lamps connected in series across 500 volts, as in Fig. 3. It was required to find the voltage actually existing between the points *ab* and the points *ad*, and to determine the discrepancies between these voltages and those that will be indicated by a voltmeter whose resistance is 50,000 ohms, when it is connected across the same points. Since there are five similar lamps across the 500 volts, there will be one-fifth of the voltage across each, or if E represent this voltage, we have, $E = \frac{500}{5} = 100$ volts. The voltage across *ab* is equal to E and is therefore 100 volts. That across *ad* includes three lamps and is therefore $3E = 3 \times 100 = 300$ volts. The current taken by the lamps can be found by dividing their input, namely, 50 watts, by the voltage across them. Hence, if I be assumed to be the current, we have, $I = \frac{50}{100} = 0.5$ ampere. The resistance of each lamp is equal to its voltage divided by its current. If R be this resistance, we have, $R = \frac{E}{I} = \frac{100}{0.5} = 200$ ohms. This would be the value of the resistance across *ab*, and that across *ad* would be equal to the resistance of three lamps, or $3R = 3 \times 200 = 600$ ohms.

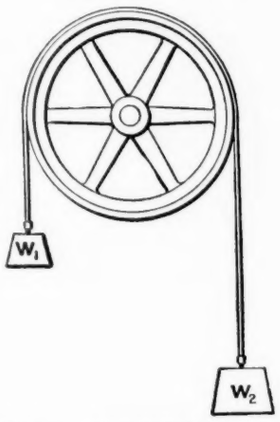


FIG. 6. TWO WEIGHTS SUPPORTED OVER A PULLEY

When the voltmeter is connected across *ab*, we have a resistance of 200 ohms connected in parallel with one of 50,000 ohms, the two in multiple being connected in series with the lamps between *b* and *f*, whose resistance is $4R = 4 \times 200 = 800$ ohms. When the voltmeter is connected across *ad* we have 600 ohms in multiple with 50,000 ohms, the two being connected in series with the lamps between *df*, whose resistance is $2R = 2 \times 200 = 400$ ohms. These two sets of conditions are illustrated in Figs. 4 and 5. Taking up the case of Fig. 4 first, let us represent the resistance between *af* by R, that between *ab* by R_1 and that between *bf* by R_2. We then have $R = R_1 + R_2$. To know R_1 we must find the multiple resistance of the resistances between *a* and *b*. Thus, we have, $R_1 = \frac{1}{\frac{1}{200} + \frac{1}{50{,}000}} =$ 199.20 ohms, from which, $R = R_1 + R_2 = 199.20 + 800 = 999.20$ ohms. The total current flowing will be this resistance into the total voltage; namely, 500 volts. Hence, $I = \frac{500}{R} = \frac{500}{999.20} = 0.5004$ ampere. If E_1 be the voltage across *ab*, we have, $E_1 = IR_1 = 0.5004 \times 199.2 = 99.68$ volts. Since the actual voltage, when the voltmeter is not connected in, is 100 volts, the discrepancy is $100 - 99.68 = 0.32$ volt, making the error 0.32 part in 100 parts, or $\frac{0.32}{100}$, which multiplied by 100 would give, $\frac{0.32}{100} \times 100 = 0.32$ per cent. error.

In the case of Fig. 5 we have, $R_1 = \frac{1}{\frac{1}{600} + \frac{1}{50{,}000}} =$ 592.885 ohms. Substituting in the value for R gives, $R = R_1 + R_2 = 592.885 + 400 = 992.885$ ohms, from which $I = \frac{500}{R} = \frac{500}{992.885} = 0.503583$ ampere. The voltage across *ad* will therefore be, $E_1 = IR_1 = 0.503583$

$\times$ 592.885 = 298.57 volts, and since the actual voltage without the voltmeter is 300 volts, the difference is 300 — 298.57 = 1.43 volts, which makes the error 1.43 parts in 300 parts, or $\frac{1.43}{300}$, giving an error of $\frac{1.43}{300} \times 100$ = 0.477 per cent.

The diameter of the pulley in Fig. 6 is 18 in., and it is to be driven by an electric motor, through reduction gearing, at 30 r.p.m. What size motor would be required to lift W_2 if its weight is 1500 lb. and that of W_1 is 300 lb.? (Assume that there is no loss of power in the hoisting system.)

Erecting and Testing an Engine in 1870

By D. W. Foster

It was a good many years ago that I helped to erect and test an engine having some points which I think will interest the readers of *Power*. In fact it was in the first months of the year 1870, and I was an articled apprentice in a Suisse works building many kinds of machines.

An engine had been sent from England and the directions for erecting and testing were in English, so I was detailed to assist a man by the name of Pasquet to do the work and translate the directions. The boxing was noticeable as all parts of them that had to be removed were screwed on and each screw was marked with a number and the directions said that these screws must be removed in sequence. I found that this system saved much time. The engine, after being tested, was to be reshipped in the original boxing.

When the box containing the piston rod was opened, Pasquet was astonished as one could see that the rod was sprung. The chief engineer was sent for and the rod was taken to a planer and laid in the platen and a surface gage showed that the rod was sprung about three-eighths of an inch, if I remember aright. Off went the chief to write to the builders, while Pasquet sat down on a stool and seemed to be thinking very hard. At last he called me and said, "What do the directions say about that rod?" I got the papers and the supposed trouble was made clear. Under the heading piston rod I read about as follows: "It will be noticed that the piston rod is cambered. On the crank end will be found a line marked *O*, this line must register with a line on the crosshead and the nut must then be set up; if this is not done, the camber of the rod would not point upward, and its value would be lost. We here explain that the idea of the camber is to take the weight of the piston from the lower side of the cylinder, thus preventing wear."

This was a new idea all around and Pasquet sent me to the chief to explain. He did not seem to take any stock in the system, but it was not his affair, so we followed the directions.

The next thing that was out of the usual was in the studding for the cylinder head. Two of these studs were about ½ in. longer than the others, why, we did not see until we came to put on the head. Then the reason was clear, as these long studs could be easily entered into the stud holes of the head and the head easily slid into place. This was the first time any of us had seen the idea, but I have often seen it since. The cylinder head was scraped to a joint. It was cast hollow and exhaust steam was led to the cavity by a copper tube and then to the condenser.

The piston was encircled by a band of copper holding the rings in place, and in the piston was another new idea. The rings were of the segmental type set out by flat springs. These were made of german silver or some whitish metal, and all were mounted in a U-shaped solid ring. On the back face of this ring was cut a ratchet the teeth of which engaged with a sort of plunger that passed through the back plate of the piston, and the end of this plunger came in contact with the face of the cylinder head at the end of the stroke, forcing it forward, thus imparting a slight rotary motion to the ring carrying the segmental piston rings. The idea of this was to prevent scoring the cylinder.

The front cylinder cover was cast hollow and piped, as was also the back head. Metallic packing was used in the stuffing-box, and it was the first I had ever seen. It was very long, at least 14 in. and had grease rings fitted between each section of packing, which was made up of a double cone split horizontally and two solid rings bored to fit the tapers of the cones. These were of some soft metal, and the rings were of cast iron.

The pillow blocks were of composition, scraped to a fit on the two sides parallel to the shaft, but instead of the bottoms bedding down, as we had always been used to seeing, a new construction was used. A wrought-iron plate was machined and fitted to the bottom of the pedestal opening for the pillow block. In the middle of this piece was machined a rounded score at right angles to the shaft, with a radius of perhaps two inches. The bottom of the composition pillow block was machined in the same way, and between the plate and the block a piece of turned and hardened steel shafting was placed, this giving a certain amount of adjustability to the bearing.

Oiling the crosshead slides and gibs was effected in a new way, so far as we knew. The crosshead guides were wide and the shoes were long. The guides were cast hollow, and holes were drilled from the faces into the cavities. These holes were staggered, and about six on each side. Into these drilled holes were fitted composition cylinders in which were glass balls, or marbles. A shoulder prevented the balls from rising more than ⅛-in. above the surface of the guide when the cylinders were in proper position, and the balls were held up against the shoulder by a spring. When the crosshead shoe passed over the balls, they were of course depressed, but when the shoe had left them the spring closed the opening; that is, the ball rose up against the shoulder. As the cavity in the guides was supplied with oil from a tank suspended about two feet above the guides a pressure of approximately two pounds was obtained, so we had a forced-feed oiling system.

The valves were of the Corliss type, but were peculiarly made, as they were segments of a circle equal to the bore of the cylinder. This was done to reduce clearances. Just how these valves were made in detail I do not remember.

How well the engine stood the test of long wear I do not know, but the shop tests were very satisfactory and the economy was much better than any of which we had any record. I think the engine was built by Merlie & Tate. These people built sugar machinery. At any rate the work on the engine was as good as could then be obtained in the world, and not a file was required to bring the parts together. I may add that the engine cylinder was about 36-in. diameter and 48-in. stroke.

EDITORIALS

Edison Medal Presented to Benjamin G. Lamme

THE American Institute of Electrical Engineers has this year awarded the Edison Medal to Benjamin G. Lamme. The award was made for singular and distinguished accomplishment in the "Invention and Development of Electrical Machinery." Thus the year's crowning honor in electrical work has been paid to a designing engineer, for it is as a designing engineer that Mr. Lamme has preëminently worked out his genius.

His work has been so varied and his versatility so great that a detailed mention of the developments in which he has been concerned might be mistaken for a history of the art of the design of electrical machinery. There are certain landmarks in his work that are of more than passing interest to the electrical fraternity.

In the field of power generation and transmission the first generators that transformed the power of Niagara into electrical energy were his work, and in connection with this power house the use of twenty-five cycles, alternating current, for heavy power work was established. Following related designs, this general type of machine reached its climax in the old Manhattan engine-type machines, giants of their time, standing somewhat over forty feet high. Realizing the possibilities of the steam turbine, Mr. Lamme set himself with equal determination to the development of the modern high-speed turbo-alternator, which reaches today in a single unit capacities many times the old Niagara or Manhattan machines and in a fraction of the space required by either.

In the railway field he has been associated with the development of the railway motor since its conception. He has been of later years so much connected with alternating-current apparatus and developments that it is a matter of wonder to look back twenty-five years and find that the same man was responsible for shaping the design of the direct-current railway motor along such lines that the motors of that time bear a startling resemblance to the direct-current railway motor of today.

In the industrial field Mr. Lamme's greatest contribution is the development of the induction motor. Working with Mr. Westinghouse, he took Mr. Tesla's ideas and reduced them to a piece of apparatus which in the squirrel-cage type is recognized to be the simplest possible machine for the conversion of electrical into mechanical energy.

In connection with the American Institute of Electrical Engineers Mr. Lamme has rendered signal service to the electrical art. In 1912 and 1913, when the A. I. E. E. standardization rules were under consideration for revision, the ablest men in the electrical profession in this country sought for some time for a basic principle, some simple fundamental which should serve as a keynote in making a change so important as this change in the recognized electrical standards of a nation. Many ideas had been proposed and rejected when Mr. Lamme formulated the conception that such a change should look into the future and cover, so far as human vision permitted, the practice of the years ahead rather than simply to recognize and give authority to the practice already developed and concerning which there naturally exists some difference of opinion. This idea at once cleared the air of controversies in degree similar to those of the present peace conference and established the basis upon which the present revised rules stand—a monument to the saneness of their framers.

No mention of Mr. Lamme's work is complete unless it touches his interest in young men and his service in the training of the graduates of technical schools for their work in practical design and manufacture. This interest is broader than the plain estimation of the young man's technical brain and its development; it concerns as well a broad human sympathy and an interest in the young man's character and personality which is repaid by a warmth of loyalty that has no measure in the ordinary relations of a commercial organization.

Heat Balance, United States Nitrate Plant Number Two

IN THE design of a modern power plant reliability has first place. Securing this, the engineers devote themselves to detailed studies to the end that the unit output will be had at the highest efficiency and the lowest cost. American engineers have long been striving to deliver to the switchboard a kilowatt-hour of electrical energy per pound of coal burned. In recently designed stations, favored with good coal and adequate and cool condensing water, this figure has been more closely approached than the most optimistic would some years ago have dared to believe. A curve, showing the decrease in coal consumption per kilowatt-hour for representative stations, plotted against years, reveals the markedly favorable influence of the steam turbine, of stoker and boiler improvements. To lower the curve below the point where the modern turbine puts it requires of the engineers wide and up-to-the-minute knowledge as to design, and consummate skill in operation.

The reader therefore will appreciate Mr. Lockwood's article elsewhere in this issue, which treats of heat-balance studies of the United States Nitrate Plant Number Two, with the design of which he and E. R. Welles and William Shoudy, of the J. G. White Engineering Corporation, had so much to do. This plant, a war plant, designed and built in a great exigency, has commanded the attention of engineers the world over. Distinguished engineers who have visited it have become absorbed in studies of it and have come away impressed by the achievement. Several articles in recent issues of *Power* have described the station. The one in this issue tells what it was designed to do in the way of performance. No need in this column to give figures—the article is replete with them. In them American engineers have reasons for gratification.

Report of the Prime Movers Committee

"THIS Committee's report is not so much to tell what has been developed during the war as to state what has been done despite the war." So did N. A. Carle, chairman of the Prime Movers Committee of the National Electric Light Association, introduce the committee's report at the recent convention of that body in Atlantic City. The statement fits the situation, for the difficulties of labor, materials and transportation were indeed great. That the industry surmounted them so well is concrete evidence of the excellence of its engineering personnel particularly.

Though a whole afternoon was devoted to discussing the report, as usual several subjects were not touched upon. This committee is one of the most important, if not the most important, of the National Electric Light Association, and again this year it was evident that too little time is available for consideration of its report in convention assembled.

He who attended the meeting in the hope that he might hear or participate in discussion of the specific troubles which the large turbine has developed during the trying period of the war was disappointed. Of course few expected such discussion, but it was gratifying to hear the expressions of confidence in the large single-shaft turbine by the leading engineers of America's great power stations.

The committee said that, " . . . with the present constructional problems of prevailing frequencies and speeds and the recognized factors of safety, efficiency and cost, the size of the systems today will hardly warrant units larger than thirty thousand kilowatts capacity. In particular cases, and until increased reliability, as well as improvements in operating efficiencies, have been established, even larger systems will not justify the use of larger units." While on the whole the last statement finds support, the discussion by W. B. Finley, superintendent of motive power, Interborough Rapid Transit Company, New York, in which he told of experience with the operation of three thirty-thousand and one sixty-thousand kilowatt units, would indicate that, for his conditions at least, with the large units the performance is such as give the highest sense of security against interruptions due to faults within themselves. Mr. Finley pointed out that, compared with the capacities of both the Seventy-Fourth and the Fifty-Ninth Street Stations, 195,000 kilowatts for the former and 205,000 for the latter, a thirty-thousand kilowatt unit is really a small one. Mr. Finley is confident that the troubles that have developed in the large single-shaft machines at Fifty-Ninth Street will be eliminated. Moreover it is significant that the builders of such machines, while bringing to bear the great resources of their research departments to obviate certain defects, do not contemplate any radical departure in type.

We believe that W. L. Abbott, chief engineer, Commonwealth Edison Company, Chicago, expressed the thought of many when he said before the meeting, "We may confidently contemplate the use of turbines larger than we have been using in the past. . . . We may gradually rely upon units of larger proportionate size to the total station capacity than we have in the past."

A pleasing announcement was that made by Philip Torchio, New York Edison Company, who said that the Power Station Committee of the American Institute of Electrical Engineers had secured the coöperation of builders of large turbines in the preparation of papers on the design of large turbines. He expects such papers to be presented before the coming October meeting. Of course all interested look forward to something unusually comprehensive in these papers. Perhaps this is the beginning of that real coöperation between designer and user which Mr. Sniffin, of the Westinghouse Electric and Manufacturing Company, again so admirably urged before the convention.

I. E. Moultrop will find unanimous acceptance among engineers of his suggestion to the committee that to really get somewhere with the use of higher steam pressures, manufacturers of power-plant equipment build a two-thousand or three-thousand kilowatt experimental station, using the pressures anticipated. Certainly, this is a quick way and surely one of the cheapest ways of finding the practicable limitations of high steam pressures.

The one regrettable feature of the report and discussion of it was the total lack of anything on water power; but the committee explained that this was unavoidable.

Misleading Plant Statistics

IT WOULD be hard to name a simpler task in plant statistics than to keep a periodic record of the rated capacity of the installation, and yet a recent examination of operating data from about a dozen otherwise well-run stations disclosed an amazing laxity as to the size of the plants at various dates. The records examined covered a five-year period, each group of plant sheets purporting to show all the important operating and cost data of a given year. Provision was made on all the forms for recording the number and ratings of each generating unit, with other physical plant data, loads, etc.

Some of the sheets failed to distinguish between kilowatt and kilovolt ampere ratings of units, putting down the plant capacity one year under the former and the next year stating it as the same rating under the latter classification. Probably this was due to ignorance on the part of the staff of the accounting departments, which was in the final analysis responsible for the data set forth, but as these records were prepared and filed with a long-established state commission, it is a pity that there was not an engineering check on the information spread before the authorities.

Complications arose, too, from the failure of those preparing the record sheets to state the dates on which certain generating units were withdrawn from service to permit the installation of larger sets in their places, and again, in some plants the direct-current side of one or more motor-generator sets was added to the kilowatt or kilovolt-ampere rating of the units driven by prime movers directly.

A weak spot in station data will be found in many plants undergoing extensions or remodeling with regard to the fitness of various units for service at given dates, as it is sometimes important to be able to testify that the capacity of a station at a particular date was exactly this or that figure. These and similar matters are often entirely overlooked, so that it sometimes becomes necessary to answer with an estimate based on memory questions that should be as clearly and definitely settled by fully recorded data as engineering rating practice now makes possible.

Correspondence

Using Steam in Hot-Water Radiators

Those having to do heating work know that hot-water radiators can be used for steam heating but that steam radiators cannot be used in hot-water heating, as the latter are connected at the bottom of the sections only, whereas the former are connected at both the top and bottom. The reason why more hot-water radiators are not used in steam work is because the steam radiators are slightly cheaper and more easily repaired; probably there being fewer joints is another reason.

Heating engineers design many systems in which the pipework may be used for steam heating, but engineers who do their own work sometimes put it over the heating expert by putting up a job that the latter will condemn as unworkable.

Such a system is shown in Fig. 1. The job is really in practical use; it is noiseless in operation with either low or high steam pressure. Hot-water radiators are used throughout and where connected as shown, the automatic air vent is placed at *B*, which is the steam-entrance end. This is directly opposed to the usual way, as when the radiator is connected at the bottom on both ends the air vent is placed at *C*. The building is three stories high with a straight riser, a drip being placed on the low end of the main in the cellar. Radiators are on each floor and appear to give good results whether connected at the top or at the bottom on the inlet end.

A 2-in. pipe runs to first-floor radiators, a 1½-in. pipe

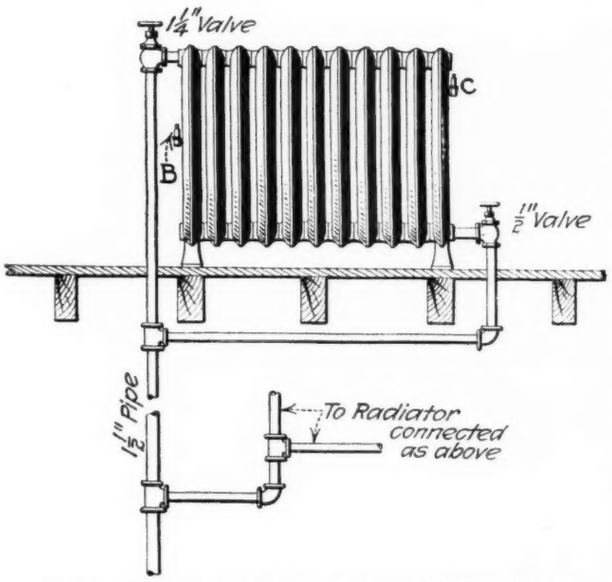


FIG. 1. HOT-WATER RADIATOR PIPED FOR STEAM

to second and 1¼-in. to third. Some are floor and others are wall radiators. I have turned steam into this system at both low and high pressures, but in the latter case I let the steam enter slowly, the pressure being 60 lb. gage. In every case the system heated up with no hammering and was practically noiseless.

There are no water seals or loops. The returns pass through a V-notch meter, and the water is pumped back to the boiler.

Fig. 2 shows the run of the mains in the basement. Exhaust steam is generally used, the pressure being so low that it will not move the gage hand away from the

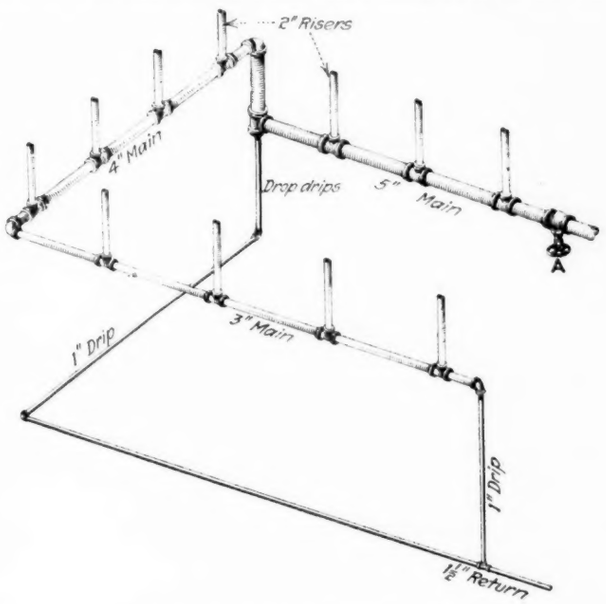


FIG. 2. RUN OF BASEMENT MAINS

pin. A reducing valve was connected to be used when no exhaust steam was available, but the pressure in the system was so low that this valve allowed a small quantity of live steam to pass even when the exhaust was in use. It was therefore removed and a 1-in. hand-controlled valve connected in the line in the boiler room.

The valve *A*, Fig. 2, was put in a convenient place for the people in the building to close off the steam without going to the boiler room when either exhaust or live steam was being used. Suitable back-pressure and relief valves were arranged in the boiler room to take care of the exhaust steam if it should be cut off in the building.

In one-pipe jobs with only one connection to each radiator there is generally considerable crackling noise when the steam is turned into an empty system; in the job herein described there is practically none of this noise.

In another job the radiators are all of the steam type and are connected at the bottom and at each end, with one riser to the three flats. They work equally well with low pressure, but not so well with high-pressure steam, as in the latter case the water of condensation seems to be held back somewhat in the radiators. It does not "pound," but makes a disagreeable gurgling noise. This latter job has been in use for fourteen years and has never given any serious trouble outside of the noise mentioned.

JAMES E. NOBLE.

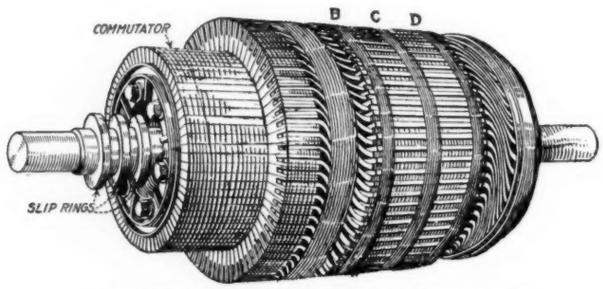
Kingston, Ont., Canada.

Heating of Banding Wires on a Self-Excited A.-C. Generator

Recently the center band on a three-phase 25-kv.-a. 230-volt self-excited alternator in our plant broke. This band consisted of No. 20 steel piano wire and was $\frac{5}{8}$ in. wide, as were the other two core bands, and located on the armature as shown at *C* in the figure.

The band was renewed in the customary manner, using the same kind of wire. The armature was replaced, the clearance between polepieces and armature checked and found to be all right, so the machine was started and run up to full speed. After running for about three minutes without load, the center band suddenly burst.

A careful examination failed to reveal the cause, but did, however, indicate that the solder had been thrown off this band previous to its bursting. Another band was carefully put on and the generator again started up, but with no excitation, and no trouble was experienced on a thirty-minute run. With excitation, however, the machine was operated but one and one-half minutes, and upon shutting down it was found that the center band was very warm and had started to melt solder at



ARMATURE OF SELF-EXCITED ALTERNATOR

various places. The other two core bands were also warm, although the armature proper had not increased in temperature. A magneto test showed that all three bands were electrically connected to the armature core, thereupon the bands *B*, *C* and *D* were removed, the portion of the core underneath them was thoroughly painted with insulating paint, and three new bands were installed over insulating paper. These were tested out for grounds on the armature and found to be clear.

As before, the armature with full excitation could be run only about one and one-half minutes before the bands heated up. From this it appeared that eddy currents induced in the banding wires were responsible for the heating.

The remedy which suggested itself was either to cut down the amount of magnetic material in each band or to use a nonmagnetic conductor for the bands. Not having the nonmagnetic material at hand and it being imperative that the machine be put in commission, the only solution was to reduce the area of the bands. This was done by cutting out the center portion of each of the three bands so that instead of each being $\frac{5}{8}$ in. wide there was a $\frac{3}{16}$ in. band, then $\frac{1}{4}$ in. space and then a $\frac{3}{16}$ in. band. This cured the trouble, and the machine has ever since been operating satisfactorily with these bands.

The specifications were obtained from the manufacturers of this machine, and it was learned that the original banding was of No. 20 phosphor bronze wire, each band being $\frac{1}{2}$ in. wide with three clips. Evidently, the steel bands had been installed about a year ago, when the armature was repaired.

I would like to hear from some readers of *Power* why the steel bands had been successful for a year and were unsuccessful when renewed with slightly narrower bands of the same gage wire and the same number of clips. I have never seen the foregoing explained or even mentioned in any book dealing with troubles of motors and generators. This experience may help someone else out of similar difficulty and any discussion will undoubtedly be of value to many operators. C. D. CORWIN.

Groton, N. Y.

Replacing a Boiler-Feed Valve

About five years ago I had charge of a hotel in Chicago where there was but one boiler and that was a low-pressure one for heating the building. It was fed from the city water supply as the water pressure was high enough to feed it at the highest steam pressure the safety valve would allow.

After I had let some water into the boiler one day, I tried to close the $\frac{3}{4}$-in. stop-cock, but it broke in half. The head of the plug went straight up and of course the water also. The check valve was between the cock and the city main, and I had both hot and cold water coming out at the one opening, and there was no way to shut off either one in the boiler room. I called to the cook, who was across the hall, to shut off the city supply valve in the kitchen, which he did, but as I had five pounds steam pressure on the boiler it only made matters worse. I still had plenty of water, but oh, so hot! I had to have the cold-water valve opened again enough to keep from getting scalded.

I had a pocketful of waste and a screwdriver, so I started packing the waste into the hole, and when it was full I got a furniture clamp from my tool box and screwed it on as tight as I could and stopped the water so it didn't leak a drop. This happened on Sunday, and I didn't have another stop-cock to replace the damaged one and there wasn't room enough for a valve. I went to some other hotels to try to get one, but no one had any. There was plenty of water in the boiler to last over until Monday, so I decided to let it go at that.

On Monday I got a new stop-cock from a supply house, but another problem confronted me: How could I put it on without draining the boiler? It was "good and cold," about 10 above. I thought out a plan and it worked fine. I raised two pounds steam pressure, then closed all drafts and opened the flue doors. A vacuum was thus created in the boiler, so that when I opened a gage-cock air was drawn in. I then put the new stop-cock, with a check valve between it and the boiler, on a piece of $\frac{3}{4}$-in. pipe about four feet long, so I wouldn't have to get my hands in the hot water again. I next took off the broken pipe. Some water came out, but with only a little pressure, so by taking the pipe that I had the valves on by the end, I caught the threads all right. In a few minutes I had steam on again and no one lacked heat.

I am passing this on, but hope no one will have a similar experience. JOHN D. COOPER.

Chicago, Ill.

Engine Crosshead Pounds

I have a 20¾ x 48-in. Corliss engine the crosshead of which is of the regular style with a key adjustment. When running, a loud knock is present in the crosshead, but only on the outward stroke, which increases when the boiler pressure is increased. It is necessary to key

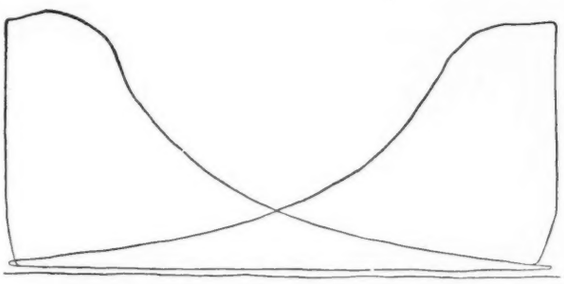


DIAGRAM TAKEN FROM POUNDING ENGINE

up on these crosshead brasses every other morning and sometimes every morning. If there is only a slight knock in the morning, it is sure to be bad by noon. The engine runs under and makes 81 r.p.m. The accompanying diagram is from this engine, taken with a 40 spring, boiler pressure 80 lb. I will be glad to have readers of *Power* tell me how to overcome my trouble. E. HOLLIS.

Mt. Olive, Ill.

[A little more compression would doubtless help matters.—Editor.]

Marine Engine Bearing Leads

The following incident in connection with the overhauling of marine-engine bearings, at a time when so many young engineers are entering this field, may be of assistance.

A chief engineer in the service of a well-known shipping company was transferred to another of the company's steamers with a view of overcoming the serious trouble that had been experienced due to pounding bearings.

On being taken aboard the ship and introduced to the retiring chief by the superintendent engineer, the "leads" taken from the crank and crosshead bearings were shown to him for his information and future guidance. Because of long experience with different types of engines, he at once came to the conclusion, on account of the thinness of the wire, that the leads were either faked or improperly taken, and expressed an opinion as to the possibility of operating any marine engine with the brasses so finely adjusted. While being shown around the engine room, he requested the second engineer to take "leads" from the high-pressure engine crosshead bearings. The engineer at once moved the engine, by means of the auxiliary turning engine, until the high-pressure crank was on the bottom center, when he removed the crosshead caps and brasses, inserted the pieces of lead wire ($\frac{1}{16}$ in. thick) and screwed the nuts down to the same marks at which they were previous to loosening them.

On loosening the brasses and taking out the leads they were found to be identical with the ones in the chief's office. The new chief then asked the engineer to turn the engine while he placed his hand on the crosshead block and guide, and immediately he felt the upward movement ordered him to stop. On taking off the "leads" this time, it was found that the top brasses had barely touched the wire.

The crank bearing of the same engine was then tried and the second engineer, following his usual method, turned the crank exactly on the top center and the "leads" secured were the same as the sample shown. He was asked to move the engine off the top center quite a bit and then move it back again until the chief decided it was near enough the top, and by feeling the crosshead block knew it still carried the weight. The "leads" now showed the crank brass was barely touching them.

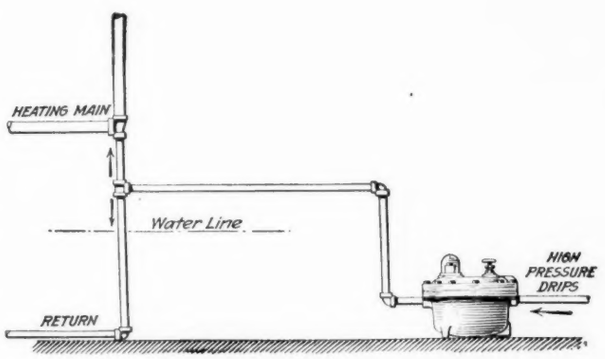
The same procedure was carried out with the other engines with the same results.

The mistake was made, of course, by overlooking the fact of the piston hanging up in the engine cylinder at the ends of the stroke, clear of the pins, and the flattening of the lead wire was made in pulling the piston down. W. G. GRAY.

Medicine Hat, Alberta, Canada.

Piping High-Pressure Trap Discharge to Heating System

One bane of an engineer's existence is leaky traps. I have tried many kinds to find the one that will stay tight and do the work. In every case some heat escapes in the form of vapor due to the release of the hot water at the pressure at which the trap is working; and in order to get the benefit of this vapor, I discharge it, during the winter, into the heating system. This is easily done by connecting the vapor pipe of the drip tank, if there is one, with the heating system and placing a stop valve on the vapor pipe leading to the atmosphere, so it can be closed in winter and opened in summer.



TRAP AND PIPE CONNECTIONS

If there is no drip tank, the connection should be made to a steam riser, above the water line of the heating system, so that the vapor will ascend into the heating system and the water gravitate to the return pipe. The illustration is intended to show how the connections should be made. In case the trap should blow through or the bypass be left open by a careless attendant, the steam is not wasted, as it goes into the heating system and less steam has to be passed through the reducing valve. W. T. MEINZER.

Brooklyn, N. Y.

Right-Hand and Left-Hand Fans

In his article on "Fans and Blowers in the Power Plant" in the issue of Feb. 4, Mr. Strohm states that the discharge of a blower is designated as right-hand or left-hand by facing the pulley and noting the side the exhaust is on.

This is contrary to the Government specifications, in which it is stated that in designating the discharge of ventilating sets the hand will be determined by the side on which the motor is mounted when the observer faces the discharge side of the fan and when the fan is standing on the deck. Thus, a top 45-deg. up discharge, left-hand, delivers air upward at 45 deg. toward the observer and the motor at the left operates with a clockwise direction of rotation. I should like to know whether there is an actual difference in stating the hand of a blower for commercial and Government uses.

EARL M. FEHRLIN.

Elizabeth, N. J.

[Fan manufacturers do not agrce on the method of determining the hand of a fan or blower. Some of them follow the Government specification given by Mr. Fehrlin and others use the method stated by Mr. Strohm in his article. In view of this lack of uniformity, the relative positions of the discharge outlet and the driving pulley or motor should be so clearly stated that no confusion can arise.—Editor.]

Pointers on Pumping Hot Water

The article by M. A. Saller, "Pointers on Pumping Hot Water," page 212 of the Feb. 11 issue, is well worth reading and the admonition not to inject cold water into the hot-water line is the right "dope."

I recall a small plant in which a very efficient method of collecting and feeding returns was used and this hot water all passed through a duplex pump. I have seen the feed-water thermometer registering 240 deg. F. at this plant and steam blowing from a pet-cock on the pump discharge, yet the pump never skipped a stroke.

The returns were taken from several high-pressure heating coils used for drying purposes, and the returns were collected in the ordinary cast-iron receiver, with a duplex pump attached. This receiver was not over six inches above the discharge deck, yet the pump worked wonderfully well. The receiver was not vented to the atmosphere ordinarily, but worked under from 10 to 15 lb. pressure. A check valve was tapped into the receiver to let in air if the pressure fell below atmosphere, which it might do if a machine was started with the coils full of cold water.

The engineer in charge said that he had instructed the operators to blow the cold water all out of the system before starting a drier, but once in a while one fooled him, so he put the check valve in to handle the condition.

Every piece of apparatus was equipped with a modern trap, and examinations of the valves were made at regular intervals. They had a hot-water heating system and used live steam at night, passing it through a heater which was within 25 ft. of the pump and about 8 ft. above it. A modern trap was connected to the 2-in. discharge line from the heater, and this discharged into the receiver. A maximum pressure of 60 lb. was turned into the heater, and the condensate, after going through the trap, receiver and pump, showed a temperature of 260 degrees.

The engine exhaust heated the raw water through an induction heater to about 140 deg. The engine operated compound condensing. Then the feed water went through a second heater fed by the auxiliaries, steam air pump, feed pump, circulating pump, etc., and left there at from 190 to 200 deg. The water then entered the receiver and mixed with the condensate and was finally pumped to the boilers.

The secret of the excellent running of the pumps was due to the following: The engineer never vented them to the air, but made the pressure keep the cylinder full of water. He never used metal valves as he could not pump water much over 212 with them, but employed a fibrous type of valve, which remained tight. The pistons were also kept in good shape.

The six pumps were all of the piston type. Once in twelve or fourteen months he put in new linings, pistons and rods. He was then able to pump the water at a high temperature. His theory was that if the piston leaks a little the water squeezes by at a pressure of about 135 lb. into a pressure of perhaps 6 or 8 lb. and the water, at high temperature, flashes into steam and then the pump is "steambound." That is all the secret there is to it.

I saw the performance of these pumps and can say that I believe the suggestions given are worth carrying out.

C. W. PETERS.

Boston, Mass.

Running Steam Engines with Compressed Air

It is sometimes possible or desirable to operate steam engines with compressed air in the event that no steam is available and compressed-air service is to be had. This is often the case on the test floor of a machine shop, on construction work where compressed air is used or in the case of ships in dry dock where the boilers are shut down and it is desirable to operate the ship's dynamo to furnish light.

Small and medium-sized steam engines will operate very well and can be used for an indefinite time on compressed air if the pressure is suitable. Ordinarily, there need be no change in the setting of the engine valves. Simply connect the air service to the steam pipe of the engine and use air instead of steam. It is often desirable to disconnect the exhaust system of the engine so that it can exhaust directly into the atmosphere, thus eliminating back pressure.

In expanding in the engine, the air takes heat from the cylinder walls, thus cooling these parts to a considerable degree below the temperature of the atmosphere. While a certain amount of water is usually carried into the cylinder with the air and will assist in lubrication, it is well to arrange for more certain cylinder lubrication than this. Thick cylinder oils such as employed for steam service should not be used, for they are intended for use in a heat which will thin them somewhat and if used with air the cold will render them less fluid. Practical experience has shown that common machine oil such as used for bearing lubrication gives satisfaction.

V. A. LYMAN.

Balboa, Canal Zone.

Inquiries of General Interest

Angularity of Connecting-Rod—What is meant by angularity of the connecting-rod of a steam engine? H. G. S.

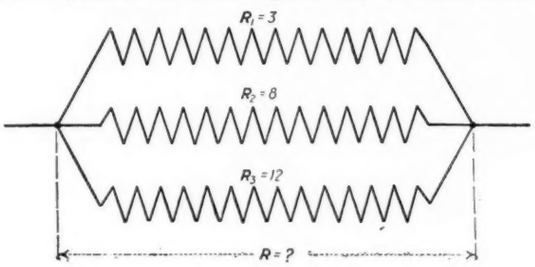
The term refers to the angular position of the rod at any time when the center line of the rod, passing through the center of the crank and crosshead pins, is at an angle with the direction of stroke of the piston.

Inspecting Leakage of Closed Feed-Water Heater—How can it be known whether a closed feed-water heater is leaking? J. N.

Leakage of a closed exhaust-steam feed-water heater will be revealed by a discharge of water along with the exhaust, especially from the drips. The best test of leakage is to observe whether there is discharge of water from the drips when the feed pump is operated without the engine or other exhaust discharging through the heater.

Joint Resistance of a Circuit—If three resistances, of 3, 8 and 12 ohms respectively, are connected in parallel, what is the joint resistance of the group? R. G. S.

The joint resistance of a group of three resistances connected in parallel as in the figure, may be found from the



formula, $R = \dfrac{1}{\frac{1}{R_1}+\frac{1}{R_2}+\frac{1}{R_3}}$ where R equals the joint resistance; and R_1, R_2 and R_3 the respective resistances.

In this problem $R = \dfrac{1}{\frac{1}{3}+\frac{1}{8}+\frac{1}{12}} = \dfrac{1}{\frac{13}{24}} = \dfrac{24}{13} = 1.846$ ohms.

Efficiency of Boiler, Furnace and Grate—What would be the percentage of efficiency of boiler, furnace and grate obtaining an evaporation equivalent to 10.95 lb. of water from and at 212 deg. F. per pound of dry coal containing 14,645 B.t.u. per pound? A. D. K.

Expressed as a formula, efficiency of boiler, furnace and grate =

$$\frac{\textit{Heat absorbed by boiler per pound of fuel fired}}{\textit{Heat of perfect combustion per pound of fuel}}$$

As evaporation of a pound of water from and at 212 deg. F. requires 970.4 B.t.u., the heat absorbed by evaporation of 10.95 lb. would be $970.4 \times 10.95 = 106{,}258.8$ B.t.u. and for coal containing 14,645 B.t.u. per pound, the efficiency of boiler, furnace and grate would be $\dfrac{106{,}258.8}{14{,}645} = 0.7255$, or $72\frac{55}{100}$ per cent.

Relative Stresses of Girth and of Longitudinal Seam—Why is the girth seam of a boiler twice as strong as the longitudinal seam? N. R.

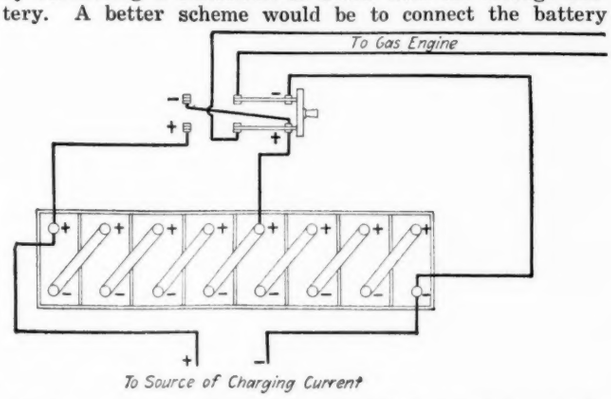
The strength of a joint is no greater because it is used as a girth seam, but the stress pulling the joint apart is only one-half as much per unit length of a girth seam as per unit length of a longitudinal seam. As an example, suppose a cylindrical shell to be 72 in. in diameter. Then the whole length of a girth seam would be $72 \times 3.1416 = 226.195$ in. The gross area of a head 72 in. in diameter would be $72 \times 72 \times 0.7854 = 4071.5136$ and each pound pressure per square inch would cause a stress of $(1 \times 4071.5136) \div 226.195 = 18$ lb. per inch length of the girth seam; but for 1 in. length of a longitudinal seam, each pound pressure per square inch would cause a stress of $\frac{1}{2}$ of $(1 \times 72) = 36$ lb., or twice as much as the stress per inch of length of the girth seam.

Trouble from Steambound Feed Pump—What causes a feed pump to become steambound, and how can the trouble be overcome? R. N. A.

A leaky check valve at the boiler and leaky pump valves and piston packing may allow hot water to work back into the water end of the pump when it is standing still or moving at a very slow speed. To restart pumping, stop the pump and open the drain cocks on the water end and leave them open until water is discharged by them, free from vapor, indicating that the water end is filled with water. Until the leaky parts are made good, close the boiler-feed stop valve whenever the pump is not required. When pumping hot water, the pump may become steambound because the suction lift is too great, resulting in such low pressure on the suction stroke that the hot water bursts into steam, which prevents the cylinder becoming filled with "solid" water. The trouble can be reduced by injecting cold water into the suction. But the only sure remedy is to place the pump low enough for the suction water to be delivered under sufficient head for keeping the pump cylinder filled with water at a higher pressure than that at which water of the temperature would vaporize.

Battery for Sparking Gas Engine—We have a 16-volt storage battery that I would like to use for ignition purposes. The gas engine requires only about 8-volt current. Can a resistance be connected in series with the battery, so as to cut the voltage down to about 8 at the coil terminals, and use it to spark the engine? The battery is charged from a low-voltage generator. L. K.

It is doubtful if satisfactory operation can be obtained by connecting a resistance in series with the storage battery. A better scheme would be to connect the battery



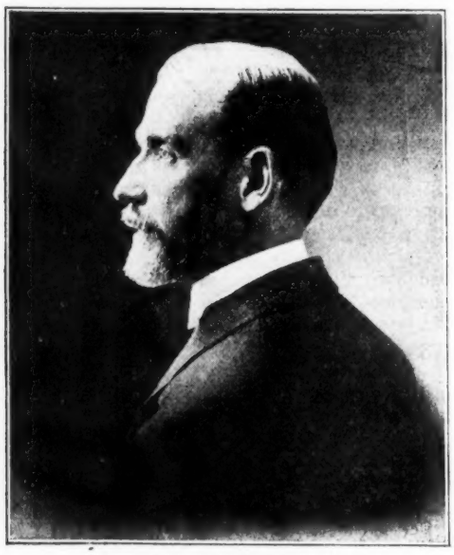
through a two-pole double-throw switch, as shown in the figure, so that four of the cells can be used at a time for ignition purposes. With this scheme the battery may be charged at any time, even when part of it is being used to ignite the engine.

[Correspondents sending us inquiries should sign their communications with full names and post office addresses. This is necessary to guarantee the good faith of the communications.—Editor.]

Salary Schedules and Employment Discussed at A. A. E. Annual Convention

At the annual convention of the American Association of Engineers held May 12 and 13 in Chicago, salary schedules, employment problems and opportunities, proper compensation and society inter-relations were the main features discussed. Ninety delegates from thirteen of the chapters and three clubs were present, although the attendance was 186 at the largest session.

With reference to salaries, A. M. Van Auken, chairman of the committee on compensation of the Chicago Chapter, presented a comprehensive 19-page report containing schedules of salaries for the various engineers employed in municipal, railway, highway, public utility, rural and other fields. The committee took the stand that the profession of engineering, taken as a whole, was insufficiently paid or was not paid in proportion to the high degree of responsi-



F. H. NEWELL

bility entailed or the technical training required to perform the work. It was their opinion that the principle of a square deal for everybody should underlie all rules of compensation and that technical men must demonstrate their work both to their employers and the public before they receive the compensation due them. In the determination of this compensation consideration must be given to the effort or cost of the educational training, the years and character of experience in the particular line, as well as total years' experience, length of time in employer's service, character and personality, degree of efficiency and special qualifications. The uncontrolled law of supply and demand was not deemed a just method by which to determine the compensation for valuable services. The committee made a number of specific recommendations such as limiting the time of work to eight hours per day or 44 hours per week, recommending an increased rate for overtime, the observation of national holidays, and the payment by the employer of moving expenses when the place of employment was shifted.

Adoption of the report was not asked for, but it was recommended that the national body use the data in a nation-wide study and seek to formulate a more comprehensive schedule. A recommendation was adopted providing that abstracts of all laws applying to engineers and surveyors, which degrade or harm the engineer, be collected and published along with suggestions for better laws in the interests of the public and for the good of the profession.

In the employment department F. H. Myers indicated that 10 per cent. of the dues is now spent. From 300 to 350 members were on the list to receive the bulletin of positions open. Circular letters to employers gave 5 per cent. returns. For the week ending May 10 twenty-one men had been placed in positions averaging $150 per month at a cost of $45, as compared to $1890, the figure employment agencies would have demanded for the same service.

Changes in the constitution were as follows: A national practice committee is authorized to report on questions of ethical policy and conduct; a grade of "candidate junior" is added; chapters are to recommend grading of candidates; junior members may now vote but not hold office; the last past president is a director; the board is authorized to make mutual agreements with other societies. Entrance fees are increased automatically $2 for each 500 members above 1000, the count to be made in December and fixed for a year. Apprehension that the fees would be so high as to keep out younger members gave way to the idea of increased service that could be rendered by the larger income.

Following an explanation of the similarity in work of the Engineering Institute of Canada with that of the Association, by Fraser S. Keith, secretary of the former, it was voted to leave the Canadian field to the Institute and to coöperate fully with it. Another indication along coöperative lines was a telegram from the Oregon Engineering Society asking for a proposal either to come into the association as a chapter or to make joint membership possible.

The next annual convention will be held in St. Louis. The result of the ballot letter for officers was as follows: President, F. H. Newell; vice presidents, W. W. DeBerard and F. A. Evans; new directors, W. W. K. Sparrow, P. E. Harroun, R. Burnham, F. D. Richards, A. A. Matthews and G. F. Collins.

Electrical Engineers Hold Their Annual Business Meeting

The American Institute of Electrical Engineers held its annual business meeting Friday evening, May 16, in the auditorium at the Engineering Societies Building, New York City. In the absence of the president, Comfort A. Adams, the vice president, W. B. Jackson, occupied the chair. He said that the year just ended had been full of accomplishment, but that the new one gave promise of being even more so.

The report of the Board of Directors for the year ended Apr. 30, 1919, was distributed at the meeting. Secretary F. L. Hutchinson announced the election of officers for the coming administration year as follows: President, Calvert Townley, assistant to the president of the Westinghouse Electric and Manufacturing Co. Vice presidents, C. E. Skinner, engineer of research division, Westinghouse Electric and Manufacturing Co.; John F. Fisken, chief engineer, Washington Water Power Co., Spokane, Wash.; N. A. Carle, chief engineer, Public Service Electric Co., Newark, N. J.; L. R. Jorgensen, electrical and hydraulic engineer, San Francisco, Calif.; Wills Maclachlan, inspector, Electrical Employees' Association, Toronto, Ont., and A. M. Schoen, chief engineer, S. E. Underwriters' Association, Atlanta, Ga. Managers, L. E. Imlay, superintendent, Niagara Falls Power Co., Niagara Falls, N. Y.; L. F. Morehouse, equipment engineer, American Telegraph and Telephone Co., New York City, and F. F. Fowle, consulting electrical engineer, Chicago, Ill. For treasurer, George A. Hamilton, Elizabeth, N. J., was reëlected.

The foregoing, together with the following holdover officers, will constitute the Board of Directors for the next administrative year: C. A. Adams, Cambridge; W. A. Del Mar, New York; G. Faccioli, Pittsfield; W. A. Hall, Lynn; E. H. Martindale, Cleveland; F. D. Newbury, Pittsburgh; E. W. Rice, Jr., Schenectady; Charles Robbins, Pittsburgh; Charles F. Ruffner, St. Louis; W. I. Slichter, New York; Wilfred Sykes, Pittsburgh. At the meeting of the Board of Directors F. L. Hutchinson was reëlected secretary for the coming administrative year.

President-elect Calvert Townley, in a brief address, said he considered it no time to make a speech, but that to decline to say a few words would be discourteous to the association which had honored him by making him president. He said the question of honor, however, was secondary, and an engineer was worthy of the name only in so far as he went ahead and did things. In the same way the

Institute must be constantly on the watch to find new means for service if it is to be worthy of the name of a national institution.

The Weaver memorial tablet, erected in acknowledgment of the services of William G. Weaver to the Institute, was unveiled, following an appreciation of Mr. Weaver's work by Dr. A. E. Kennelly. To Mr. Weaver, said Dr. Kennelly, was due much of the credit for the establishment of the great technical library now quartered in the Engineering Societies Building, and it was fitting that his portrait should form part of that library, for "Where a man's heart is, there should his head be also."

Mr. Weaver's talent for ferreting out and appraising electrotechnical literature amounts almost to genius, said the speaker. Whereas most men able to judge one type of technical literature have no ability for appraising other types, Mr. Weaver was skilled in evaluating all. His work as editor of the *Electrical World* established a high standard for electrotechnical literature. Mr. Weaver also has a remarkable talent for judging men. While most men are self-seekers, the speaker declared, Weaver is preëminently a seeker of others, and there are many men now leaders in the engineering world who owe their first success to him.

Edison Medal Presented to Benjamin G. Lamme

At the annual business meeting of the American Institute of Electrical Engineers held Friday evening, May 16, the Edison Medal was presented to Benjamin G. Lamme, chief engineer of the Westinghouse Electric and Manufacturing Co., for his invention and development of electrical machinery. The presentation ceremonies were taken part in by Dr. Carl Hering, chairman of the Edison Committee, who gave a brief history of the Edison Medal, and by B. A. Behrend, who related the achievements of Benjamin G. Lamme. The medal was presented by William B. Jackson, vice president of the American Institute of Electrical Engineers.

Dr. Carl Hering in his address told how the Edison Medal was founded upon the initiative of an organization known as the Edison Medal Association, composed of old associates and friends of Thomas A. Edison, who subscribed a trust fund for that purpose under an indenture dated Feb. 11, 1904, whereby the American Institute of Electrical Engineers agreed to award the medal annually.

By the terms of the deed of gift executed under date of Mar. 26, 1908, this gold medal is awarded each year to a resident of the United States or its dependencies or of the Dominion of Canada, "For Meritorious Achievement in Electrical Science, Electrical Engineering, or the Electrical Arts."

The award is made by a committee of the Institute consisting of 24 members, three of whom are appointed by the president each year, to serve for a term of five years, three elected by and from the Board of Directors each year, to serve for a term of two years, and the president, secretary and treasurer of the Institute ex officio.

The medal was designed by James Earle Frazer and bears on its obverse a portrait of Thomas A. Edison and on its reverse an allegorical conception, "The Genius of Electricity Crowned by Fame."

After telling what the medal was, Dr. Hering related the crowning achievement in the life of each of the recipients of the Edison Medal awards, who were: Elihu Thompson, 1909; Frank J. Sprague, 1910; George Westinghouse, 1911; William Stanley, 1912; Charles F. Brush, 1913; Alexander Graham Bell, 1914; Nikola Tesla, 1915, and John J. Carty, 1917.

In discussing Mr. Lamme's work B. A. Behrend said that the choice of the Medal Committee was especially fitting since Mr. Lamme had just completed thirty years of service in the electrical field. His work served as a bridge connecting the days when the science of electricity was in its incipiency with the present, in which it has become firmly established. Mr. Lamme's versatile personality has impressed itself on the engineering profession and is part and parcel of its development. His untiring labors are typical of the science which he has helped to build up. Mr. Behrend said that in his many-sided intellect as well as in name and even in personal appearance Mr. Lamme was likened to his predecessor in the electrical field, Benjamin Franklin.

The speaker told of Mr. Lamme being born in Springfield, Ohio, in 1864, and graduated from the Ohio State University as a mechanical engineer in 1888. He entered the testing department of the Westinghouse Electric and Manufacturing Company May 1, 1889. At that time the development of practically all types of polyphase alternating-current apparatus, railway generators and motors was a matter of the future, in which Mr. Lamme took a leading part. He invented and designed much of the apparatus and many of the systems and methods now in general use, and has taken out 153 patents, many of which are of fundamental importance and cover inventions that have contributed very largely to the present methods of generating, transmitting and using electrical power.

In 1900 Mr. Lamme was made assistant chief engineer of the Westinghouse Electric and Manufacturing Co., and since 1903 has been the chief engineer of this company. He is the author of many technical papers presented before engineering societies, some of which are regarded as classics. A paper on the Induction Motor, published 18 years ago, is used in many schools, and permission has recently been given for including it in the textbooks of the Naval Academy at Annapolis. His inventions and writings have made him well known among electrical engineers in Europe, as well as in America. In 1915 he was, upon nomination by the American Institute of Electrical Engineers, appointed by the Secretary of the Navy to membership on the Naval Consulting Board, and his services as a member of the board during the war were of great value to the country.

BENJAMIN G. LAMME

In response to the presentation speech by Vice President W. B. Jackson, Mr. Lamme said in part:

Most people are particularly interested in accounts of wonderful inventions or discoveries; and the cold-blooded methods of the engineer in driving through all obstacles to a desired result do not contain for them any especial elements of romance or excitement. They do not recognize that the work of the engineer carries responsibilities, which ofttimes is not the case with the inventor; moreover, they are not aware that the engineer in the manufacturing field, when he once embarks on a project, is obliged to see it through to the end and that he must stand or fall by his results. To state it very briefly, the experimental attracts more attention than the analytical. The modern engineer, especially in the electrical field, is largely an analytical man and his adventures in analysis do not appeal to the popular taste.

In an industrial organization the engineering developments are almost always the result of coöperation of many trained minds, and in consequence it is difficult to give any one man a large share of the credit. In such an organiza-

tion an individual may appear to have less opportunity to stand out prominently, in comparison with others, than where he is working more or less alone; yet it must be borne in mind that each engineer has the knowledge and experience of his coworkers upon which to build, and in this way he can accomplish results that would be impossible through his own individual capacity. Without the backing of immense resources in capital, equipment and experience, and without the greatest coöperation of many analytical minds, there could have been no such accomplishment as the modern high-speed, huge capacity turbo-generator sets. In such a development limitation after limitation, based upon previous experience, has been set aside. Each step in advance usually has offended some proven experience or practice. And, with each step, it usually was said, "This is the last," but the data from each one pointed a way to the next—and the end is not yet.

In progressive manufacturing organizations, as a rule, there can be no particular "pets." When any new line of development holds forth broader and greater possibilities, often the old and accepted practice and constructions are turned down ruthlessly in order to replace them with something more promising. Many times I have assisted strenuously in "obsoleting" some of my own best work just to make way for something of greater promise. For instance, I spent a number of my best years in doing my part in the development of the direct-current engine-type generator, up to a point where it seemed to be perfection, but I made equally great efforts in the development of the 25-cycle rotary converter which was destined to supplant, in general, the direct-current engine-type generator as a source of direct current; and still later I put equal efforts in forwarding the development of the 60-cycle rotary converter to supplant the 25-cycle machines. As a second instance of tearing down work in which I had a considerable share, I may cite the alternating-current engine-type generator, which had reached its greatest magnificence in the huge Interboro machines in New York City and which was rendered obsolete as a type by the development of the high-capacity turbo generator.

From the standpoint of development and inventions the past looms large, but how about the present and the future? In looking over the past history of electrical engineering, the engineer may be inclined to think that the golden age of development and invention is past, and that the future contains no corresponding promise of new and startling things. But I do not agree that this is so. The pioneering period may be over, but the true development age has possibly just begun. The work is growing more difficult year by year, as our accumulation of knowledge grows. We are working ahead of our data, just as we did twenty to thirty years ago. Exactness and responsibility are required to a much greater degree than in the past, for our undertakings are greater in degree. The wonderful advances in the earlier times did not seem so very wonderful while we were in the midst of them. In fact, at the time, many of them were simply hasty remedies for serious difficulties, which were accepted and adopted out of necessity. But similar situations of today are also having their remedies supplied, ofttimes requiring vastly more difficult engineering than in the past; and viewed from a twenty-year future, many of these also will loom large. It is all because we have no proper perspective of the present. So the young engineer need not be discouraged. The fact that the work is growing more difficult year by year should be, in itself, a source of encouragement.

Mr. Lamme then told of his start in engineering thirty years ago, when upon leaving college he had entered the testing department of the Westinghouse company and had the good fortune to serve under the then shop superintendent, Albert Schmid. In those days electrical machinery was built by rule-of-thumb methods and Mr. Schmid, learning that young Lamme was good at calculations, had set him to checking and verifying certain curves and designs. This led to specifications for an improved double-reduction railway motor and later the development of a single-reduction gear motor embodying many radical features the main points of which may be found in the present street-railway motor.

Status of Large Turbines*

DURING the last two years there has been a marked increase in the number of large units in operation, particularly the horizontal single-shaft type of approximately 30,000 kw. capacity.

A consideration of the practical limit in size of single-shaft machines, so far as the questions of design enter into the problem, indicates that in general higher efficiencies at equal or less cost per kilowatt output can be obtained as the size of the unit is increased, particularly in capacities up to 30,000 kw.; and although one single unit of 45,000 kw. capacity is now in service, it cannot be assumed that the size of single-shaft units can be increased indefinitely.

From a manufacturing standpoint the limitation in size of a single-shaft unit is a limitation arising partly from materials at present available for blades and revolving elements and also from several inherent constructional difficulties which must be cleared away before further increases are fully justified.

In addition there is also involved the question of economic value of increased size of machines above 30,000 kw. If such factors as maximum efficiencies, cost per kilowatt and space requirements show a fairly uniform betterment as the size of the unit is increased, then neglecting the factors of design and operation, an increase in the capacity of the single unit will show a saving with increased system-load demand.

It would appear, however, that with the present constructional problems of prevailing frequencies and speeds and the recognized factors of safety, efficiency and cost, the size of systems today will hardly warrant units larger than 30,000 kw. capacity. In particular cases, and until increased reliability and improvements in operating efficiencies have been established, even larger systems will not justify the use of larger units.

The increasing size of prime movers and the increasing percentage which the individual turbo-generator unit bears to the total generating capacity of any system make the reliability of this type of machine a matter of much more importance from the operating standpoint than it was previously considered. While everyone appreciates the reduction in overhead charges due to the low investment cost per unit installed for these large machines, the low operating cost due to their increased efficiency and the low attendant labor and maintenance costs, yet operating companies must not forget for an instant that continuity of service is the bedrock of any central-station company's reputation and that the truly successful public-service company must give the community it serves the best and most reliable service possible.

With the increase in the size of the system and the recent increase in size of single units, an individual prime mover and generator often comprises 25 per cent. or more of the total generating capacity in many large companies, and the importance of these large units, as well as the necessity for their continuous operation, has increased proportionately. It is therefore becoming increasingly onerous on account of overhead charges to attempt to safeguard this capacity, and the reliable operation of the unit is absolutely essential to the satisfactory operation of the system.

Just how far it is safe to go in the installation of large generating units each company must of course decide for itself, but since units of over 20,000 kw. capacity are a rather recent development and since the service factor or ratio of hours available to total hours for some of these units is 90 per cent. or less, as compared with 97 to 99 per cent. for some of the older units, the importance of giving this matter careful consideration is plainly evident.

On the other hand, it must not be forgotten that certain of these large machines have records of continuous performance and output which surpass anything previously

*Excerpts from report of Prime Movers Committee of National Electric Light Association.

considered possible. For example, one of the 25,000-kw. units operated at 67 per cent. load factor during a 51-day run without shutdown; another machine of the same capacity has completed two 77-day runs at 67 per cent. load factor in the first instance and 70 per cent. in the second, while one of the 35,000-kw. units operated at 65 per cent. load factor for a 70-day run without shutdown.

Troubles With Large Units

In analyzing the causes of trouble as indicated by the operating records of the class of units of 20,000 kw. and over, there are several features of design that appear to be the most frequent sources of trouble. Labyrinth packings and thrust bearings have probably contributed to the major part of large-turbine operating difficulties. While these troubles in themselves have caused a considerable loss in operating time, they have also been responsible in a considerable number of instances for the development of far more serious troubles. Among these may be mentioned excessive vibration of parts, breaking of buckets and dangerous rubbing of stationary and moving elements, which in extreme cases have resulted in permanent deflection of shafts.

The most serious situation that has developed in the type and sizes of units under consideration, however, has been the number of quite recent turbine-wheel failures. In several instances these accidents have resulted in the complete wrecking of the units concerned. Such accidents, which are without parallel in the history of steam-turbine development, can hardly be considered as bearing directly on the question of performance of large-sized units, but rather as a factor to be considered in the improvement of design and construction of a specific type of unit.

The situation is now a critical one, and while any definite statement at this time would be premature, the committee wishes to indicate the necessity for early action both in safeguarding against further possible failures of machines now in operation and in definitely reaching solutions of those problems which involve important features of design and construction.

In general, however, the records of operating performances of these larger units, while too incomplete for definite conclusions, do indicate that there is every reason to expect as high a standard of performance for the recent types of large-capacity single-shaft units as had been obtained in the operation of machines of earlier design and smaller capacities. It is hardly overstating the case, however, to say that the records for reliability of operation of the larger units during the past two years have not been up to this standard.

While some of the difficulties may, without doubt, be directly concerned with operation, the greater percentage of trouble has been the direct result of shortcomings in details of design, materials or construction. On smaller-sized units, however, similar details of construction have proved to be much more reliable in their operation. It would seem that not only is the same degree of reliability of operation essential, but that a greater degree of reliability becomes more imperative with increasing sizes of machines and higher standards of service demanded by those industries dependent upon electric-power supply.

Discussion

W. L. Abbott, Chief Engineer, Commonwealth Edison Co., Chicago, Ill.: In substance Mr. Abbott had the following to say relative to turbines. The performance of large turbines during the last two years has been of great concern, particularly turbines of 20,000-kw. capacity and over. So much has it interested engineers that it is the subject of study by another organization, which he did not name, but whose report he expects to be forthcoming within a few months. Although a number of failures have occurred in large machines, nothing in the situation warrants distrust of the large units of the particular design which has developed trouble, the trouble by the way being due to a number of faults which were incidental. These faults are now in the way of being corrected.

Relative to the ratio of the largest unit to the total station capacity installed, Mr. Abbott pointed out that this ranged from 7 to 100 per cent. Units as large as 33 or even 50 per cent. of the station capacity may with confidence be contemplated. The mechanical troubles to which these units have been subjected will be overcome, and we may gradually rely on units of proportionately larger size, compared with the total station capacity, than we have been using in the past.

H. M. Cushing, Engineer, Buffalo General Electric Co.: Mr. Cushing stated that the nature of their load was such that no long runs of any of the units, which by the way are of 20,000-kw. capacity, are necessary. One or more units are shut down every night, and it is seldom that any one unit makes a continuous run of two or three days. These machines have been giving a service factor of 89½ per cent., operating under a total steam temperature of 650 to 700 deg.

W. B. Finley, Superintendent of Motive Power, Interborough Rapid Transit Co., New York City: Mr. Finley urged that the committee standardize its form of report so that comparison might be facilitated. In discussing experience with the operation of three 30,000- and one 60,000-kw. reaction turbine in the Seventy-Fourth Street Station of his company he pointed out that the Fifty-Ninth Street Station, which is of 205,000-kw. capacity, and the Seventy-Fourth Street Station, which is of 195,000-kw. capacity, were operated in parallel, the machines being operated so that there was available for either station about 15,000 kw., or half the capacity of any one of the three machines. The 30,000-kw. unit is the basic unit used by this company, and Mr. Finley pointed out that it was a comparatively small unit, considering the total station capacity.

Mr. Finley urged a standardization of turbine performance, saying that they worked out such a system of standardization for use by the Interborough Rapid Transit Co. When the large units were first installed by this company there was no sense of security, but this, however, has been replaced by the strongest sense of security, which is accounted for by the satisfactory performance of all of the units. The 60,000-kw. machine is operated six days a week, being shut down on the seventh for inspection. When the 30,000 units were first put in operation, piping supports were used, which, when the turbine heated, tended to distort the piping, the distortion being magnified by the time it reached the turbine, causing the dummies to run. The trouble has been overcome and the shutdown period greatly lengthened. Mr. Finley is confident that the troubles that have developed in the 30,000 single-shaft units in the Fifty-Ninth Street power house will be overcome.

Philip Torchio, New York Edison Co.: The limit in capacity of a single-shaft turbine is not 45,000 kw., at least theoretically, says Mr. Torchio, and he deems it unwise at this time to place any limit to the capacity that may be developed by this type of machine. He thinks that with this type the chief question is one of speed, and that for the speed used we may have exceeded the capacity of the unit; that is, by decreasing the speed somewhat, the larger wheels might be able to operate satisfactorily.

Mr. Torchio advised that the Power Station Committee of the American Institute of Electrical Engineers had secured the coöperation of large turbine builders to prepare papers on turbine design, and it was expected that these papers would be ready for presentation at the October meeting of that institute.

Oscar Junggren, Engineer, Turbine Department, General Electric Co., Schenectady, N. Y.: Mr. Junggren said that he could not add anything to the statement already made and printed by the General Electric Co. (This statement is included in the committee's report.)

The company, he said, had the same difficulties which everyone had encountered during the war. There was great difficulty in securing suitable materials, and the difficulty extended to the engineering, drafting and shop forces. Another factor contributing to the bad state of affairs was the large building program which the company undertook for the Navy and the Emergency Fleet Corporation. The turbine business of the company, he said, had almost doubled. He pointed out that the company had already completed destroyer turbines which will not see their hulls for two years. He stated that the company is under no

apprehension that it cannot carry out its obligations as related to its turbine business.

E. H. Sniffen, Manager Power Section, Westinghouse Electric and Manufacturing Co., East Pittsburgh, Penn.: The problems embraced within the design and operation of steam turbines are as important as any the industry faces.

Since eighteen or nineteen years ago engineering enterprise involved in design has been left to the manufacturers themselves. Mr. Sniffen hopes and is of the opinion that we will see greater coöperation between builders and manufacturers. He believes that it is well that the various designs have been evolved and tried out. He would like to see more standardization and coöperation of thought, as in the electrical end of the industry. There should not be such diversity of opinion between manufacturers and engineers, as the satisfactory operation of a turbine depends upon details of design.

N. E. L. A. Annual Convention

NATIONAL Electric Light Association held its 42nd annual convention at the Million-Dollar Pier, Atlantic City, N. J., May 19 to 22, 1919. This year's convention proved to be one of the most successful that the association has ever held; a total of about 2500 members and guests registered. This year's exhibits were greater and better than at past conventions, the 85 exhibitors taking a total of 50,000 sq.ft. of space, or twice that of any previous year. In all a total of 18 technical and business sessions were held on Tuesday, Wednesday and Thursday. The keynote of the convention was service and constructive coöperation.

The first meeting, a general and executive session, President W. F. Wells occupying the chair, was held on Tuesday morning. Mr. Wells spoke of the cordial welcome that has always been given the association by Atlantic City, and introduced the mayor, Honorable Harry Bacharach, who said in part that "Atlantic City does not want as residents men who are not 100 per cent. American citizens. Neither does it want any conventions save those whose membership represents the same type of Americanism." He told how Atlantic City went over the top in all the patriotic drives and how it took care of the dependents of its men in the service. After his address the Mayor presented the association with the key to Atlantic City.

Mr. Wells' Presidential Address

Following Mayor Bacharach, W. F. Wells made his presidential address in which he laid stress upon the problems that the utilities have to contend with today, such as fair treatment of employees, satisfying customers, high costs, the Bolshevik movement, Government ownership, etc. Mr. Wells said in part: "As we were able during the war to meet and solve the unforeseen problems presented, so we will now go forth in the same spirit and cope with those that are to come. From now on, our particular duty is to the people. Our duty to that part of the people who are our customers is to render them satisfactory service. Our duty to those who are our employees is to maintain loyalty by fair treatment. To those who own our securities, it is to maintain the integrity of their investments. Our duty to the others of the commonwealth under whose rules and regulations we operate is to furnish convincing information that we are giving them a better service for less money than can be obtaind in any other way."

During his address Mr. Wells said regarding the higher scale of prices of nearly everything that enters into electric light and power service: "These specific problems are all factors of one fundamental, psychological equation, to wit: 'The revenue from contented customers shall equal a satisfactory return for labor and capital.' For notwithstanding the physical and financial factors, the important factors in the fundamental equation, are psychological. The revenue from contented customers must equal the satisfactory return for capital and labor. Our problem, therefore, of keeping our customers contented with our service and maintaining their good will is largely a matter of psychology. Good will, though unrecognized by the courts in rate cases, is one of our most valuable assets and depends upon the manner in which we come in contact with the public. Money, although very important, is only one of the factors of a satisfactory return for one's service. The college professor is often better satisfied with his stipend than a broker with five times the income."

In regard to regulation and inspection of utilities the speaker expressed the opinion that, "If our customers, employees and investors are satisfied, there is little danger that any political demagogue will endeavor to favor one at the expense of either of the others." He said that we should not overlook the Bolshevik movement and urged that the members of the association take into immediate consideration this question in order that definite steps may be taken to consider this matter seriously in coöperation with other national bodies in this country.

In regard to municipal ownership or administration Mr. Wells expressed the belief that it was economically unsound and said: "We can use as examples of the results of public ownership the railroads, the merchant marine, the express, telegraph and telephone companies, which under present Government administration have not only increased rates for a service much inferior to that furnished in the past, but which on account of continuously increasing operating cost may still further increase the rates to the public."

Acting Secretary S. A. Sewall read a report of the work of the association during the year, and was followed by W. H. Blood, who read his report as insurance expert for the members of the association. This report was printed and distributed at the meeting. It not only deals with the activities of the insurance expert as an adviser and expert witness for the member companies in legal suit brought against them in cases of fire assumed to be of electrical origin, but also deals with his work on the revision of the National Electrical Code.

Report of Rate Research Committee

Alex. Dow presented the report of the Rate Research Committee, of which he is chairman.

Much discussion followed the presentation of this report. It combined in part with the discussion of the progress report presented by R. J. McClelland, chairman of the special joint committee on Determination of Power Factor in Polyphase Unbalanced Circuits.

In regard to the power factor of customers' circuits Mr. Dow expressed the opinion that the small customers were most difficult to deal with; that with a customer using 300 hp. and over it was a comparatively easy matter to make them see the advantage of maintaining high power factor. The matter of penalizing the customer for low power factor, although justified, was a problem difficult of solution; and to anyone considering it he would advise giving the matter most serious consideration before putting the project into effect. The point was brought out that it was not the large motors, in general, on the system that caused low power factor but a multiplicity of small partly loaded machines.

It was brought out in the discussion that it had been found by investigation carried on in Italy that a reactive kilovolt-ampere cost about one-third to produce what it did to produce a kilowatt of energy. Of course this would very somewhat with the type of plant, location, etc. A suggestion was made, and one that seemed to meet with favor, that the reactive kilovolt-amperes and kilowatts should be metered separately and the customer billed for both. This would give the user of the power an opportunity to practically eliminate the kilovolt-ampere bill entirely if he would maintain the power factor of his electrical system at a high value.

Tuesday afternoon five sessions were held: First accounting session, first commercial session, first electrical-vehicle session, first and second technical hydro-electric sessions. At the first technical and hydro-electric session the report

of the Committee on Prime Movers was presented by the chairman of the committee, N. A. Carle. The discussion on the steam turbine part of this report is published elsewhere in this issue.

Second Technical and Hydro-Electric Session

The second technical and hydro-electric session was held in the Belvedere, eleventh floor, of the Hotel Traymore. At this session E. B. Meyer, chairman of the Committee on Underground Construction and Electrolysis, presented the report of the committee. It was evident from the report and the discussion that followed that there is a tendency to standardize the important elements in underground construction. There appeared to be considerable objection to the use of paraffin as a joint filler, due to shrinkage.

The report of the Committee on Overhead Lines and Inductive Interference was presented by A. E. Silver, chairman of the committee. The part of the problem that the greatest interest was shown in was the relations with the telephone companies. There appeared to be a well-defined opinion among the members that the power company should coöperate in dealing with the telephone companies in the interest of fairness to all.

At the close of the session W. C. L. Eglin, chairman of the Committee on Safety Rules and Accident Prevention, announced that the National Electrical Safety Code was to come up for discussion at the meeting on Thursday morning and he hoped the member companies would offer constructive suggestions for formulating a code that would be satisfying to all parties interested. The speaker paid high tribute to the Bureau of Standards and its work toward formulating a satisfactory safety code and said that there had been much misunderstanding regarding this code. He made it clear that he wanted to go on record as in favor of the code, that the code was here to stay and that the proper thing to do was for all interested parties to get together and formulate a code that is workable and that will make electrical construction safe without imposing any hardships upon the operating companies.

Professor C. F. Scott, Yale University, expressed himself as being gratified with the spirit of constructive coöperation shown by all those taking part in the meeting and compared this with conditions existing a few years ago, when every interest was for itself.

An audience that filled the Rose Room of the Hotel Traymore to standing capacity attended the second general and executive session, held on Tuesday evening. The reports of the Public Policy Committee and the National Committee on Gas and Electric Service were presented, followed by addresses on the sales of utility securities to customers and on socialism.

Third General and Executive Session

On Wednesday morning the third general and executive session was held. One of the principal features was an address, "Planning for Power," by George Otis Smith, Director of the Geological Survey, Department of the Interior, in which he described the needs of this country for additional electric-power facilities. In regard to Secretary of the Interior Lane's proposed superpower system, the speaker said: "The picture of the super-power system demanded by the rapid growth of this industrial region [referring to the northeastern part of the country] includes a multiple transmission line of high voltage with its thousands of steel towers extending from Boston through our Eastern States, crossing the Connecticut near Springfield, the Hudson at Poughkeepsie, the Delaware near Easton, and the Susquehanna below York, and so on to Washington and Richmond. Into this unified system large-unit, steam-electric stations at tidewater and near the mine mouths and hydro-electric stations at old and new sites would deliver energy as required, and from this great power main would flow the energy to serve millions of homes, a score of railroads, hundreds of public service companies, and thousands of manufacturing plants.

Referring to the importance of cheap power, the speaker said: "Our interest as citizens in these plans for cheaper energy is far more than a commercial interest. The organization of the nation's business to obtain the lowest costs is distinctly a matter of public service, in which corporation and Government bureaus may well join efforts. Tomorrow prosperity must mean profit-sharing on a thorough-going scale, in which we shall all receive in proportion as we have served. So the industrial program which emphasizes mechanical power is the most effective assurance of better conditions for all who work in this busy world of ours."

A more complete abstract of Mr. Smith's address will appear in an early issue.

Six sessions were held Wednesday afternoon: Second accounting, second commercial, third commercial, second electric-vehicle, third technical and hydro-electric and fourth commercial.

A discussion on "Effects of the War in Isolated Plant Cost," at the third commercial session brought out the facts that previous to the war the isolated plant could produce power cheaper than the central station. However, due to the increased cost of everything that goes into the production of power, the power-cost curves of the two types of plants have crossed, and now it is possible for the central station to produce power cheaper than many of the isolated plants that could show a lower cost figure previous to the war. It was necessary before the war for the central station to sell power at a reduced price in order to meet the isolated-plant figure. This practice was considered bad business, and even now when the central station can in many cases produce power cheaper than the isolated plant, it would be poor policy to sell at the reduced rates inasmuch as the customer should be willing to pay something for the convenience of being relieved of responsibility of operating a power plant. It was recommended that an endeavor should be made to sell power on the merits of greater convenience to the owner of a manufacturing establishment rather than to try to meet the price at which the power could be generated in an isolated plant.

Power Factor in Customers' Installations

Another important discussion at this session was "Power Factor in Customers' Installations." This subject was profitably discussed from several angles. Suggestions as to how the meaning of power factor might best be explained to the customer were offered by R. H. Tillman and Prof. C. F. Scott. Robert Treat, in discussing power-factor corrective apparatus, told of the increasing use of synchronous motors and stated that such motors as now constructed are suitable for any requirements for which an induction motor is ordinarily used save where variable speed is required; they are to be found driving air compressors, pumps, blowers, etc. With a synchronous motor one pays for corrective capacity at about one-third the ordinary cost for power with an induction motor. Comparing with the synchronous condenser, static condensers and phase advancers, Mr. Treat pointed out that with a synchronous motor the losses were less than with an induction motor with a condenser for the same corrective value. The synchronous condenser is more flexible than a static condenser although the latter is more flexible for small powers. The phase advancer compares favorably with the synchronous motor, but as its production has not yet been put on a quantity basis, it is at present more expensive. Moreover, it can be used only with an induction motor having a phase-wound rotor.

A paper by R. H. Gardner on a result of low power factor was then read by Mr. Mitchell. The author emphasized that the loss in efficiency at low power factor justifies special efforts on the part of the consumer to keep the motors loaded. Furthermore, low power factor necessitates the operation of more generating apparatus to maintain a given load. It was suggested in the discussion that a bonus to customers for high power factor would compensate for the extra investment in corrective apparatus.

The last phase of this subject to be taken up was the effect of electric furnaces, brass furnaces and welding machines on the power factor. The electric furnaces have, as a rule, high power factor although this is affected by the frequency, voltage and load. With electric welding it is

customary to introduce a motor generator set where the service is alternating, but where the alternating current is used for the welding, a very low power factor results—25 to 35 per cent.

At the third technical and hydro-electric session the reports of the Committee on Electrical Apparatus and the Committee on Meters were presented and discussed. The former report deals with generators, switchboards, transformers, substations, power-factor correction and apparatus for special industrial fields. The printed report contains 108 pages. The discussion brought out considerable difference of opinion regarding standardizing transformer polarity, it being the opinion of some that subtractive polarity should not be adopted for distribution transformers, while others supported the committee's report for such standardization. On a motion the subject of polarity was referred back to the subcommittee for further consideration.

The subject of extinguishing fires in generators created considerable interest, the use of steam or water or both being advocated for this purpose, although preference was shown for the latter. It was pointed out that immersion of the armature coils in water if not prolonged would not permanently injure them provided they were dried out soon after. Abstracts from this report will appear in early issue of *Power*.

At the fourth general and executive session, held Thursday morning, the report of the National Nominating Committee was presented, which announced the election of the following national officers: President, R. H. Ballard, Southern Calif. Edison Co.; first vice president, Martin J. Insull, Middle West Utilities Co.; second vice president, M. R. Bump; third vice president, Frank W. Smith, United Electric Light and Power Co., New York; fourth vice president, Walter H. Johnson, Philadelphia Electric Co.; treasurer, H. C. Abell, American Light and Traction Co. Members of the executive committee to serve three years: W. H. Atkins, Edison Electric Illuminating Co., Boston; P. G. Gossler, A. B. Leach & Co., New York; D. H. McDougall, Toronto Power Co., Ltd.; member of executive committee to serve two years, R. J. McClelland, Electric Bond and Share Co. The secretary was instructed to cast one ballot for the nominees, and they were declared duly elected.

Award of John Fritz Medal to General Goethals

In recognition of his distinction in the engineering profession and as the builder of the Panama Canal, Major General George Goethals has been awarded the John Fritz Medal. The presentation of the gold medal, with an engraved certificate stating the origin of the medal and the specific distinction, was made by Ambrose Swasey, past president of the American Society of Mechanical Engineers, in presence of a large and appreciative assemblage of engineers and guests in the auditorium of the Engineering Societies Building, 29 West 39th St., New York City, on Thursday evening, May 22.

Addresses were made also by Henry L. Stimson, former Secretary of War, and W. L. Saunders, past president American Institute of Mining and Metallurgical Engineers, testifying to the perseverance, skill, singleness of purpose and devotion to duty by which General Goethals has brought to successful completion one of the greatest works of the ages and placed him on the list of men whose engineering achievements are known the world over.

Mr. Swasey in his address said General Goethals had gone to war with the element when his country was at peace, and had truly represented himself in the ten years' fight on the canal job as a soldier, engineer and man.

In responding the General said several other men came to his mind in accepting the medallion, chief among them being the late Colonel Roosevelt, whose courage and steadfastness as the chief executive of the nation made the canal possible. General Goethals recalled how the medical men of the army conquered the yellow fever scourge only after several of the best among them died and others were left permanent cripples for their sacrifices, which he compared to any that had occurred in the world war. In concluding he paid a tribute to the 50,000 American workmen who did their part, imbued solely with the idea that their efforts meant the future glorification of the country's greatness.

The John Fritz Medal was established in 1902 in honor of John Fritz, of Bethlehem, Penn. The medal is of gold, is awarded not oftener than once a year and is accompanied with the engraved certificate. This certificate states the origin of the medal, the specific achievement for which the award is made, and bears the names of the members of the Board by which the medal was awarded and the signatures of the president and secretary of the board. The Board of Award is formed of sixteen men, four representatives from each of the four National Societies of Civil, Mining, Mechanical and Electrical Engineers. The first award of the medal was made to John Fritz at a dinner given to him on his 80th birthday, Aug. 21, 1902. Among those who have received the medal in past years are George Westinghouse, Alexander Graham Bell, Thomas A. Edison, Charles T. Porter and Prof. John E. Sweet.

Seizures of Diesel-Engine Pistons*

By Edward Ingham

One of the principal troubles in the working of Diesel engines is seizure of the piston. When it is remembered how small is the clearance between the piston and the cylinder liner in such engines, it is rather surprising that cases of seizure are not far more frequent.

In a Diesel engine, small piston clearances are essential if a high efficiency and smooth running are to be obtained. The designer is confronted with the problem of reducing the clearance between the piston and the cylinder liner to the smallest practical limits, without at the same time involving undue risk of seizure of the piston.

When seizure takes place the results may easily prove disastrous; thus, if the motion of the piston is suddenly arrested, the energy stored in the flywheel tends to keep the crankshaft rotating, so that the crank exerts a severe pull on the connecting-rod, with the result that the connecting-rod or crosshead bolts are severely strained. Should the bolts fail, the consequences may be easily imagined. In one instance where seizure of the piston caused failure of the crosshead bolts after elongating them and reducing their diameter from 1 in. to ⅞ in., the connecting-rod was badly bent, and fracture of the piston and the cylinder liner resulted. One of the nuts from the broken bolts dropped and fouled the crankshaft and the engine frame, and as a consequence, a piece of metal was broken out of the frame, while the crankshaft, which had four double-sweep cranks, was twisted evenly throughout its entire length, the angle between the first and the last cranks being about 15 degrees.

It may be said that seizures of Diesel-engine pistons are mostly caused by overheating of the piston and the expansion of the metal which results. As already pointed out, the clearance between the piston and the cylinder liner must be extremely small. If a piston expands much more than the liner, the small clearance is reduced to such an extent that the piston cannot move freely, and seizure is the consequence.

The tendency to seizure is aggravated by the fact that in the ordinary trunk-piston engine, where the piston is attached directly to the connecting-rod, the forces imposed on the piston do not act in the direction of the axis of the cylinder. Owing to the obliquity of the connecting-rod, a more or less severe side pressure is exerted on the cylinder walls, so that the motion of the piston is not as uniform and free as it otherwise would be.

Clearly, if the trouble under consideration is to be obviated, it is of fundamental importance that the temperature of the piston be prevented from rising too high. Hence, the question of lubrication must receive the most careful attention. Not only the piston and the liner surfaces, but the piston pin and the top bearing of the connecting-rod must be efficiently and continuously lubricated. With the horizontal type of engine, lubrication of the piston and the

*Abstract of an article in *Electrical Review*, London.

liner surfaces can be effected satisfactorily by a single feed on the upper side, since gravitation assists in distributing the lubricant; but with engines of the vertical type the lubricant must be supplied through a number of feeds if a thorough distribution is to be effected.

Lubrication of the piston pin and the top end bearing is effected in different ways. Special care should be taken to insure that the pin will be thoroughly lubricated at starting times. When an engine is shut down, the heat radiated by the piston, pin, etc., has a tendency to burn up the lubricant in the top end bearing, so that when the engine is again started, the lubrication of the bearing may be deficient. Overheating of the pin and the piston may then result, involving considerable risk of seizure. The majority of piston seizures appear to have been brought about in this way.

With the object of preventing overheating, some pistons are cooled by water or oil, and this is an effective method of reducing the risk of seizure, provided the circulation of the liquid is maintained.

The design of the piston must be such that the liability to distortion will be reduced to the minimum, since a very slight amount of distortion may lead to seizure. The design must also be such that expansion will take place uniformly all around the piston. There should be a good body of metal, as this will assist in the escape of the heat transmitted to the piston. Special attention should be given to the question of avoiding initial strain during casting, which might lead eventually to fracture. A fracture in a diametrical direction would be especially liable to cause a seizure. Diesel engines are of the trunk-piston type, but at least one manufacturer has introduced a crosshead type of engine. This type of engine is far less liable to piston seizures than the ordinary type. The provision of a crosshead, slides and piston rod results in the piston's moving truly and freely in the direction of the axis of the cylinder, so that side thrusts are obviated. For this reason alone, the crosshead type of engine is an improvement over the trunk type, but there are other reasons. The connecting-rod top end bearing, instead of being in the cylinder, where the heat is intense, is well away from the cylinder; hence there is less liability for the bearing and the piston to become overheated. Further, the engine is provided with forced lubrication, so that every bearing is continuously flooded with oil. A small hand pump, fitted in connection with the lubricating system, enables all the pipes and bearings to be primed with oil just before starting up, and in this way all bearings are copiously supplied with the lubricant from the commencement of the running.

Many piston seizures are to be attributed to the use of cooling water containing lime and magnesium salts. When there is a large quantity of these in solution in the water, the salts are liable to become deposited in the narrow water spaces, involving risk of overheating and fracture. The practice of allowing water to circulate for some time after the engine has been shut down will tend to prevent the deposition of the solid matter, which is mainly due to the increase in the temperature of the stationary water which takes place when the engine is stopped and the heat in the metal walls is transmitted to the water.

The Present Condition of Belgian Industries*

Information supplied by the Comité Central Industriel de Belgique, regarding the destruction of property in Belgium by actual warfare or with the deliberate intention of crippling the country's industries shows innumerable cases of the destruction of industries. Sights such as those at La Louviere, at Charleroi, at Seraing, leave no doubt as to the industrial losses which Belgium suffered in the war. Some industries, however, have been spared. The interests of the invaders themselves induced them to respect to a certain extent the food industries (mills, sugar refineries, breweries, etc.), the public utilities (gas works, power houses and water works) and the coal mines. Other enterprises were taken possession of and exploited to the profit of the enemy in spite of resistance by their owners and the workmen.

All these industries have, in the main, preserved their equipment and will be able to render valuable assistance in the work of economic reconstruction provided they receive the necessary support.

In their hasty retreat the Germans abandoned quantities of all sorts of products, which, if rationally distributed under the system which is now being organized, may serve as a starting point for future manufacturing activities.

As to the labor situation, it must be pointed out that the working portion of the population was not diminished to anywhere near the extent it was in the great belligerent countries. The fact that compulsory military service was instituted in Belgium only three years before the war and the impossibility of carrrying out conscription levies because of the rapidity of the German occupation of the country resulted in the majority of the men of military age remaining in Belgium. Many of the laboring class have suffered from privations which have temporarily undermined their health, and nearly all of them have been exposed for a long or short time, to the demoralizing influence of enforced idleness. But, in general, the working population is still there, with its hereditary qualities, which training will rapidly revive. It is ready to return to work.

*From a report by Trade Commissioner H. T. Collings, Brussels.

Latches on Fire Doors

The importance of being able to close securely all fire doors of boilers cannot be overestimated. According to *The Ausable News*, several severe accidents have occurred at one of the plants of the Consumers Power Company of Michigan, due to the fire doors being blown open as a result of a boiler tube explosion. The fire blown out of the furnace burned the men so severely that in one case a fatality resulted. As a result of these accidents the company has issued the following rules:

All fire doors must be equipped with a form of latch that will prevent the doors from opening in case of an internal explosion.

Safety representative and boiler room foremen must see that these latches are kept in operating condition at all times. It should be seen further that the fire doors are in a condition that they can be closed easily so that the purpose of having latches will not be defeated due to not being able to close the furnace doors in the first place.

All stoker operators and all others who have occasion to open a furnace door on an operating boiler must securely latch the fire door before leaving it.

An improperly operated boiler is as dangerous as dynamite.

Keep the safety valves well oiled.

When blowing off boilers open and close the blowoff valves slowly.

All steam traps should be kept clean and in working order. Traps are the only safe means of removing water from the line. Should a trap get out of order and it be impossible to repair it at once, the bypass should be opened sufficiently to pass all water that might collect.

Open each door to the boiler at least once a day and inspect carefully for leaks at all points.

Keep your hand on the stair-rail. Boiler-room stairs are often steep and sometimes are narrow and difficult.

Before entering any boiler, notify the responsible person of your intention.—N. E. L. A. *Bulletin.*

In discussing the paper on lubrication, read before the Physical Society by Principal S. Skinner, C. T. Thomsen said that it had been found that among mineral oils the best lubricants were those with a large proportion of unsaturated hydrocarbons. It is thought that the more of these that are present the more intimately the oil will adhere to a metallic surface. Now, some of the animal and vegetable oils are very largely composed of unsaturated constituents, so that this property of adherence to metallic surfaces may readily be greater in these cases. He thought compressibility was of negligible importance.—*The Engineer.*

Salt Instead of Water Used in Ammonia Absorber

In describing the Seay ammonia absorption refrigerating plant to the Liverpool Engineering Society, B. Rathmell said that it had been proved capable of making 25 tons of ice per ton of coal burned, with an estimated evaporation of 9 lb. of steam per pound of coal. In this system of refrigeration the absorbing medium used is ammonium nitrate, normally a crystalline salt. In absorbing ammonia it changes into a sticky viscous liquid form. It is stated that 3 lb. of this salt absorbs 1 lb. of pure ammonia. Thus, in the absorber the salt takes up ammonia gas, as it comes from the refrigerator or ice-making tank at low pressure and temperature, the crystalline salt changing into thick liquid form. In the generator this liquid is heated by steam coils until the ammonia is driven off again into an ammonia condenser of any ordinary type; the salt reverting to its solid form in the process.

In connection with the generator it is claimed that much economy in heating is obtainable over what can be secured in the older water and ammonia absorption plant. This is because the change of state of the salt from liquid to solid form liberates its latent heat of liquefaction, which goes toward the heat required for vaporizing ammonia; and thus of the approximately 520 B.t.u. required to vaporize each pound of ammonia, only about 200 B.t.u. have to be provided by the steam-heating coils.—*The Engineer.*

France's Electrical Bill Against Germany

According to the *Electrical Review*, London, M. Dubois recently submitted to the French Chamber of Deputies a report on behalf of the Budget Commission, in connection with the bill dealing with the reparation of damages caused by the enemy during the war. The report discusses in detail the extent of the damage to various industries.

In the case of electrical and mechanical engineering works, which represented a total working capital of $400,000,000 in 1914, the works have been destroyed in the proportion of 90 per cent. The machinery and plants were worth $94,000,000, and as prices have almost trebled in the meantime the loss under this heading amounts to $253,800,000. The raw materials and manufactured products which were removed or destroyed are stated to represent a present value of $270,000,000. It is estimated that the losses to productive labor due to six years of enforced stoppage, amount to $171,000,000 while the damages to buildings are computed at a further sum of $84,000,000. Dealing with the electric supply works, the report states that 80 per cent. of the machinery and plant, which was valued at $30,000,000, has been destroyed, and, as cost prices have risen about threefold, the loss amounts to $72,000,000. It is calculated that the losses on the working capital of $39,600,000, due to the stoppage of French labor, amount to $28,600,000, while the damage to buildings is placed at $12,600,000.

Water Power Development in France

In view of the future high cost of coal, in France, the Minister of Public Works has nominated a committee to study the most scientific methods of utilizing the country's water power on the largest scale. A further departure considered is that of erecting hydraulic laboratories, fully equipped for the investigation of turbines and other water machinery under ordinary working conditions; the erection of standardizing stations for machinery employed in the hydro-electric industry, and testing stations for such machinery.

The Technical Institute of Toulouse has gone ahead of this projected departure by planning an installation estimated to cost between 1,500,000 and 2,000,000 francs, to demonstrate practically the best conditions of working high-, medium-, and low-head waterfalls, as well as water-gaging station, with special regard to the circumstances of the region of the Pyrenees. The government has recognized the value of such individual efforts, and deemed it well to encourage them by financial help. In response to the request of the Minister of Public Works last year, the government voted 440,000 francs in aid of private hydraulic laboratories, nearly half of which has already been allotted to the Toulouse Institute. A supplementary vote of 250,000 francs has since been asked for to help the scheme for the erection at Grenoble of an electrochemical and electrometallurgical institute. The third of the existing institutes—that of Nancy—is concentrating its attenton on the use and improvement of electric motors.—*London Electrical Review.*

New Publications

INDUSTRIAL GOODWILL. By John R. Commons, of the University of Wisconsin. Published by the McGraw-Hill Book Co., New York City. Cloth; 6 x 8¼ in.; 213 pages.

One gets an idea of the contents of the book from the following list of subjects touched upon: Commodity, machinery, goodwill, the public, democracy, solidarity, theory and practice, security, labor market, insurance, health, the shop, education, loyalty, personality, depression, the world. In brief the book is an argument for the engineering theory of labor by an author who has written much on labor problems.

FUNDAMENTAL ELECTRICITY. By W. P. Wieman, Member Society Astronomers De France. Published by the Wieman Co., N. S., Pittsburgh, Penn., 1919. Cloth; 4¼ x 6 in.; 127 pages; 27 illustrations.

In this little book the author attempts to explain what electricity really is by astronomical phenomena. The sun is assumed to be a permanent magnet with its field passing through the earth and the other planets so as to give them a North and South magnetic pole similar to that of the earth.

It is claimed that an electromotive force is not generated by a conductor cutting lines of magnetic force, but by the increase and decrease in quantity of magnetic lines through a closed circuit or loop. Although this little book cannot be called a treatise on fundamental principles of electricity, in the general sense of the word, nevertheless the speculative treatment of the subject makes it interesting reading.

INDUSTRIAL ELECTRICAL MEASURING INSTRUMENTS. By Kenelm Edgcumbe, M. Inst. C. E., M. I. E. E. Published by D. Van Nostrand Co., New York, 1918. Cloth; 5½ x 8 in.; 414 pages; 260 illustrations. Price, $5.

This book treats the general subject of electrical measuring instruments, especially the principles of operation. Only elementary mathematics has been employed and then to only a very limited degree. It has been the endeavor of the author to present this subject so that the reader can obtain a clear mental picture of what is going on in the various devices.

This is the second edition and has been revised and enlarged. The expansion of all sections has been such that in order to keep within reasonable limits the author has omitted the subject "fault localization" as distinguished from "fault detection," as he has also "relays" and "overpressure devices." On the other hand, "Pyrometers" have been dealt with at some length. The sections that have been especially enlarged are those dealing with Constructional Details, Power Measurements, Induction Instruments, Current and Pressure Transformers and Graphic Instruments.

Although the author is British and naturally has treated the subject from this point of view, nevertheless, there is in the book an abundance of information that applies equally well to American practice, thus making it of value to those interested in electrical work in this country.

Personals

Julius Alsberg, consulting engineer, Chicago, announces the removal of his offices from the Tribune Building to the Marquette Building, 140 South Dearborn St.

Roland B. Page has been appointed eastern district manager for Lea-Courtenay Co., with offices at 810 Broad Exchange Building, Broad and Franklin Sts., Boston, Mass.

F. X. Meehan, who has been connected with Fairbanks Morse & Co. for the last six years, has been appointed advertising manager of the Walter A. Zelnicker Supply Co., St. Louis, Mo.

J. P. Alexander has returned to New York City with the power and mining department of the General Electric Co., 120 Broadway. Mr. Alexander has represented the company for some years in central New Jersey, with headquarters at Trenton.

George D. B. Van Tassel has been appointed Detroit district sales agent of the Power Specialty Co., operating in the territory of eastern and southern Michigan and western Ohio. His office will be in the Dime Bank Building. Mr. Van Tassel has heretofore been sales engineer of the company's Chicago office.

Charles H. Stoddard has been appointed consulting marine engineer of the Heine Safety Boiler Co., St. Louis, Mo. Mr. Stoddard has held many important positions, such as chief engineer of the Fulton Iron Works and of the Risdon Iron Works of San Francisco, civilian superintendent of shops at Mare Island Navy Yard, and more recently chief engineer of Moore & Scott Iron Works.

Irving E. Brooke, recently with the Pensacola Shipbuilding Co. as assistant to the naval architect and formerly electrical engineer with the Arnold Co., has opened an office as consulting engineer at 807 Stock Exchange Building, Chicago, for the practice of general engineering work. Mr. Brooke was formerly in charge of mechanical work in the city engineer's office, and prior to this was on the engineering staff of the Commonwealth Edison Co. He is an associate member of the American Institute of Electrical Engineers.

Engineering Affairs

The National Gas Engine Association will hold its twelfth annual meeting, in Chicago, June 2-3, with headquarters at the Hotel Sherman.

New York Association No. 44, N. A. S. E., held its annual Spring Hike on Sunday, May 18. Dinner was served at the Lincoln Hotel, Midland Beach, S. I. The attendance almost doubled that of the previous walk.

The West Virginia Public Utilities Association will hold a convention at White Sulphur, June 4-7. This is the first convention to be held by this association since the beginning of the war. A large attendance is expected.

The Combined Associations of the N. A. S. E. of Boston, Mass., including Nos. 1, 12 and 14, held a ladies' night at the Engineers' Hall on Saturday, May 17. Many prominent in the engineering field were present. An enjoyable entertainment was followed by dancing, and refreshments were liberally served. James H. Henderson was the master of ceremonies.

Business Items

The Advance Heating Co. has moved into larger quarters at 110 N. Desplanes St., Chicago, where its office and shop facilities are now combined.

The Standard Electric and Elevator Co., of Baltimore, Md., has opened a New York City office at 280 Broadway, with C. A. Yarrington in charge.

The Staunton Lighting Co., Staunton, Va., announces the following change in its personnel: James R. Wampler is now superintendent and J. W. Coffman is chief engineer.

Paul W. Koch & Co., have opened Pacific Coast offices at the following addresses: Los Angeles, 114 San Fernando Building; San Francisco, 324 Rialto Building; Portland, Oregon, 342 Sherlock Building. These offices will take care of business on the "Jiffy" adjustable cutter, speed punch and other "Jiffy" labor-saving tools.

Trade Catalogs

Foxboro Recording Psychrometers. The Foxboro Co., Inc., Foxboro, Mass. Bulletin No. 103-1. Pages 11, 8 x 10½ in. The most complete bulletin yet published on this subject.

The Griscom-Russell Co., New York City, has issued its 15-page Bulletin No. 230, descriptive of the "Reilly Water Heater." The opening pages are devoted to chapters on feed water heating and on how to compute the savings resulting from use of a proper feed water heater.

The Portable Machinery Co., Inc., Passaic, N. J., has recently published a 20-page folder entitled "Over 1000 Scoop Conveyors." It is well illustrated and shows the various uses, labor, time and money-saving features of the machine. Copy may be had free upon request.

E. Keeler Co., New York City, has recently issued a nicely bound 22-page catalog on "Cross Drum Water Tube Boilers." It is well illustrated and contains some very useful information. The last two pages are devoted to a brief description of the Keeler water-tube boiler and the Keeler return-tubular boiler.

The Liberty Manufacturing Co., Pittsburgh, Penn., has issued a new 40-page catalog "Z" of useful reading matter on the company's line of apparatus. The introductory pages on boiler-tube cleaners and the operation of turbine cleaners are especially interesting. Various types of cleaners are shown and discussed.

The American Steam Gage & Valve Manufacturing Co., Boston, Mass., has just issued a nicely embossed 31-page booklet entitled "The American Thompson Improved Indicator." This booklet fully illustrates and describes the Thompson indicator and its accessories with price list, and devotes some space to the general use and care of the instrument. A few pages are also devoted to directions for using the planimeter.

THE COAL MARKET

BOSTON—Current prices per gross ton f.o.b. New York loading ports:

Anthracite

	Company Coal
Egg	$7.80@7.95
Stove	7.95@8.15
Chestnut	8.05@8.35

Bituminous

	Clearfields	Cambrias and Somersets
F.o.b. mines, net tons	$2.15@2.75	$2.75@3.25
Philadelphia, gross tons	4.27@4.95	5.95@5.50
New York, gross tons	4.62@5.29	5.29@5.85
Alongside Boston (water coal), gross tons	6.10@6.85	6.90@7.55

Pocahontas and New River are quoted at $4.70 @5.25 f.o.b. Norfolk and Newport News, Va., for spot coal, and $7.20@8.60 alongside Boston, these prices being on a gross ton basis.

NEW YORK—Current quotations, White Ash, per gross tons, f.o.b. Tidewater, at the lower ports* are as follows:

	Mine	Company Circular		Mine	Company Circular
Broken	$6.05	$7.90	Pea	4.90	6.65
Egg	5.95	7.80	Buckwheat	3.40	5.15
Stove	6.20	8.05	Rice	2.75	4.50
Chestnut	6.30	8.15	Barley	2.25	4.00

Bituminous

	Spot	Contract
South Forks	$2.90 @ $3.25	$2.95 @ $3.50
Cambria County (good grades)	2.75 @ 2.95	2.95 @ 3.25
Clearfield County	2.50 @ 2.75	2.80 @ 2.95
Reynoldsville	2.50 @ 2.75	2.75 @ 2.95
Quemahoning	2.65 @ 2.85	2.95 @ 3.10
Somerset County (best grades)	2.65 @ 2.85	2.95 @ 3.10
Somerset County (poorer grades)	2.00 @ 2.35	2.50 @ 2.75
Western Maryland	2.25 @ 2.75	2.50 @ 2.75
Fairmont	2.00 @ 2.25	2.35 @ 2.50
Latrobe	2.10 @ 2.25	2.25 @ 2.40
Greensburg	2.25 @ 2.35	2.35 @ 2.60
Westmoreland	2.60 @ 2.75	2.60 @ 2.75
Westmoreland run-of-mine	2.35 @ 2.60	2.35 @ 2.65

Quotations at the upper ports for both bituminous and anthracite are 5c. higher on account of the difference in freight rates, and are exclusive of the 3% war freight tax.

PHILADELPHIA—The price per gross ton f.o.b. cars at mines for line shipment and f.o.b. Port Richmond for tide are as follows:

	Line	Tide		Line	Tide
Broken	$5.95	$7.80	Buckwheat	$3.40	$4.45
Egg	5.95	7.80	Rice	2.75	3.65
Stove	6.20	8.05	Boiler	2.50	3.50
Nut	6.30	8.15	Barley	2.25	3.15
Pea	4.90	6.50	Culm	1.25	2.15

CHICAGO—Current prices per ton for Illinois and Indiana coal are as follows:

Illinois

Williamson, Saline and Williamson Counties	Southern Illinois F.o.b. Mines	Northern Illinois F.o.b. Mines
Prepared sizes	$2.55@$2.75	$3.25
Mine-run	2.35@ 2.50	3.00
Screenings	1.85@ 2.20	2.75

BIRMINGHAM—Current prices per net ton f.o.b. mines are as follows:

	Mine-Run	Prepared	Slack and Screenings
Big seam	$2.45	$2.75	$2.40
Black Creek and Cahaba	3.45	3.75	3.05
Jagger - Pratt Corona	2.85	3.05	2.45
Blacksmith	....	5.25	....

Domestic quoations, slightly increased, are as follows:

	Lump and Nut
Black Creek and Cahaba	3.85@$4.50
Corona	3.40
Jagger	3.50
Montvallo	5.00

ST. LOUIS—The prevailing circular per net ton f.o.b. mines is as follows:

Franklin County	Mt. Olive and Staunton	Standard
Prepared sizes, lump, egg, Nos. 1 and 2 nut	$2.75	.....
Williamson County		
Prepared sizes, lump, egg, nut	$2.55	$2.55	$2.00@2.25
Mine-run	2.35	2.20	1.60@1.75
Screenings	2.20	2.05	1.15@1.30
3-in. lump	....	2.30	.....
2-in. lump	....	....	1.75@1.90

Williamson-Franklin rate to St. Louis is $1.07; other rates 92½c.

New Construction

PROPOSED WORK

Mass., Springfield—The National Equipment Co., 662 North Main St., will install a heating plant and electric power in the 3 story addition to its factory on North Main St. Total estimated cost, $200,000.

Mass., Warren—The Warren Steam Pump Co. plans to build a 1 story, 40 x 130 ft. boiler house and a 1 story 85 x 200 ft. factory, etc., at its plant. Estimated cost, $75,000.

Conn., Bridgeport—The Fletcher-Thompson, Inc., Engrs., 1089 Broad St., will soon receive bids for the construction of a 1 story, 65 x 100 ft. and a 1 story, 60 x 65 ft. ice plants; also a 1 story, 100 x 150 ft. cold storage building on Seaview Ave., for the Peoples Ice Co., c/o F. E. Ballard, 44 Wood Ave. Estimated cost, $150,000.

Conn., Manchester—The town will install a steam heating plant in the 3 story, 45 x 90 ft. memorial hospital which it plans to build on Haynes St. Total estimated cost, $80,000.

Conn., New Haven—The Yale Tire & Rubber Co., 827 Elm St., plans to build a factory and power house on Dixwell and Homden Ave. Estimated cost, $100,000. J. E. Hubinger, Pres. Engr. not selected.

N. Y., Border City—The Empire Gas & Electric Co., 103 Castle St., Geneva, has purchased a 100 acre site adjacent to its plant here and bordering on the Barge Cayuga and Seneca Canals and plans to build a terminal, pumping station with 2 motor driven pumps, 2,500,000 gal. daily capacity. C. F. Brunt, Geneva, Supt.

N. Y., Brooklyn—The Bureau of Yards & Docks, Navy Department, Washington, D. C., plans to build an extension to the heating plant and distributing system at the naval hospital here. Estimated cost, $830,000. Specification No. 3891.

N. Y., Brooklyn—The St. Brendons Roman Catholic Congregation, 1525 East 12th St., will install a steam heating plant in the 86 x 140 ft. addition to its church on Ave. O and East 12th St. Total estimated cost, $100,000. E. T. Lynch, 341 5th Ave., New York City, Arch.

N. Y., Central Islip—The State Hospital Commission, Capitol, Albany, will receive bids until June 4 for the construction of a 3 story, 30 x 296 ft. addition to building for acute patients, at the Central Islip State Hospital here. A heating plant will be installed in same. Total estimated cost, $150,000.

N. Y., Lake Placid—The Bowman Hotel Co., Hotel Biltmore, 43rd St. and Madison Ave., New York City, has awarded the contract for the construction of a 10 story hotel here, to the Hegeman-Harris Co., Inc., 33 West 42nd St., New York City. A steam heating plant will be installed in same. Total estimated cost, $300,000.

N. Y., Montauk—The Bureau of Yards & Docks, Navy Department, Washington, D. C., will receive bids until June 11 for the construction of a power house here. Estimated cost, $40,000. Specification No. 3889.

N. Y., New York—The Seven Hundred West End Corp., 280 Madison Ave., will install a steam heating system in the 14 story, 44 x 100 ft. hotel which it plans to build on West End Ave. and 94th St. Total estimated cost, $250,000. G. T. Pelham, 200 West 72nd St., Engr.

N. Y., Ossining—C. F. Rattigan, Supt. of State Prisons, Hall of Records Bldg., Center and Chambers St., New York City, will receive bids until June 17 for the construction of a 25 x 27 ft. pump house and a 36 x 90 ft. reservoir, also for a heating plant and the installation of 2-400 hp. boilers in the power house. L. F. Pilcher, Capitol, Albany, State Arch. Noted May 13.

N. Y., Poughkeepsie—The State Hospital Commission, Capitol, Albany, will receive bids until June 4 for the construction of a 20 x 25 ft. pump house and installing 2 pumps in connection with the additions and alterations which it plans to the water supply system at the Hudson River State Hospital here. L. F. Pilcher, Capitol, Albany, N. Y., State Arch. Noted Feb. 4.

N. Y., Rome—The Rome Gas, Electric Light & Power Co., 139 North James St., plans to issue $245,164 bonds for the construction of a gas and electric plant. A. B. Morton, Supt.

N. Y., Watervliet—P. J. Matton Boat Building Co., 1240 B'way., will install pumps at the 1000 ton dry dock which it plans to build at the company's plant here.

Penn., Altoona—The Altoona Bakery Co. will install 4 boilers in the 2 story, 118 x 120 ft. bakery which it plans to build on 28th St., from 9th to Industrial Ave. R. W. Nash, Pres.

Penn., Blairsville—The Western State Hospital for Insane, Altoona, is having plans prepared by Crooks & Cooley, Archts., Jones Law Bldg., Pittsburg, for the construction of a hospital and group of institutional buildings near here, to consist of power house, laundry, reservoir, etc. Total estimated cost, $2,000,000. G. S. Ideal, 34 South 16th St., Philadelphia, Consult. Arch.

Penn., Philadelphia—The Bureau of Yards & Docks, Navy Department, Washington, D. C., will receive bids until June 4 for installing heating and humidifying apparatus at the air craft storage plant here. Estimated cost, $75,000. Specification No. 3854. Noted Apr. 22.

Penn., Philadelphia—W. Hutchinson, Jr., will install a steam heating plant in the 6 story theatre and apartment which he plans to build on Queens Lane and Schuyler Rd. Total estimated cost, $450,000. Fisher & Jones, Westinghouse Bldg., Pittsburgh, Arch.

D. C., Washington—The Bureau of Supplies & Accounts, Navy Department, will soon receive bids for furnishing motor generator and telephone, delivery Mare Island, Cal., and Brooklyn, N. Y. Schedule No. 3693.

W. Va., Weston—The State Board of Control, Charleston, will receive bids until June 14 for the construction of sewage treatment works at the Weston State Hospital here. Plans include sewage pumping station equipped with 2 electric motors, 2 centrifugal pumps and automatic control equipment, etc. J. S. Larkin, Member.

Fla., Key West—The Bureau of Yards & Docks, Navy Department, Washington, D. C., plans to build a power house and fire protection system here. Estimated cost, $20,000. Specification No. 3896.

Ind., Indianapolis—The G. & J. Tire Co., 549 East Georgia St., will install a 45 x 60 ft., 36,000 hp. steam boiler plant in connection with the 5 story, 100 x 400 ft. plant which it plans to build. Total estimated cost, $950,000. Lockwood, Greene & Co., 38 South Dearborn St., Chicago, Ill., Engr.

Ind., Whiting—The Board of Public Works will receive bids until June 2 for one 5,000,000 centrifugal pump, two 5,000,000 gal. centrifugal pumps, one 3,000,000 gal. trifugal pumps, 1 wash water pump and 1 trifugal pump, 1 wash water pump and 1 switchboard and equipment. S. A. Greeley, 39 West Adams St., Chicago, Ill. Engr.

Mich., Detroit—The Academy of Music, c/o C. H. Crane and E. G. Kiehler, Archts., Dime Bank Bldg., will install steam heating equipment, boiler, fans and motor in the 2 and 3 story, 100 x 171 ft. store and auditorium building which it plans to build on Woodward Ave. and Parsons St. Total estimated cost, $350,000.

Mich., Grand Rapids—Mueller & Slack Co. plans to install a new 150 hp. steam engine. J. W. Stevens, Ch. Engr.

Mich., Lansing—The Hotel Michigan Co. will install a steam heating plant in the 12 story, 98 x 140 ft. hotel which it plans to build on East Michigan Ave. Total estimated cost, $630,000. C. Allen, Jackson, Arch.

Mich., Mt. Pleasant—The Transport Truck Co. plans to build a 1 story, 40 x 50 ft. power plant and a 150 x 300 ft. assembling plant. Plans include the installation of a separate steam unit in the power plant. Total estimated cost, $80,000. J. J. Bachman, Arch.

Mich., Oakwood (Oxford P. O.)—The village will install modern steam heating apparatus in the 2 story high school building which it plans to build. Total estimated cost, $230,000. Van Leyen & Schiller & Keough, Union Trust Bldg., Detroit, Arch.

Ill., Chicago—The Central Film Exchange, c/o Berlin & Swern, Archts., 19 South La Salle St., will install a steam heating plant in the 12 story, 95 x 165 ft. exchange building which it plans to build on Wabash Ave. and 9th St. Total estimated cost, $1,200,000.

Wis., Kenosha—The County Board will install a low pressure steam heating system and vacuum vapor system, (Bishop Babcock preferred) in the 4 story, 114 x 168 ft. court house which it plans to build on Park St. Total estimated cost, $400,000. White, White & White, P. S. Bldg., Arch.

Wis., Winona—The city will soon receive bids for 4 air lift pumps, having a capacity of from 200 to 400 gal. each and miscellaneous appurtenances to be installed at the waterworks.

Minn., Wells—The city will soon receive bids for the construction of a new power plant building, electrical distribution system and concrete reservoir. Estimated cost, $40,000. C. L. Pillsbury Co., 801 Metropolitan Life Bldg., Minneapolis, Engr.

Mo., Ozark—E. Hawkins, Arch., 419 Holland Bldg., Springfield, will receive bids until June 2 for furnishing heating and plumbing for the court house here.

Mo., St. Louis—Hall & McKay, contractors, Chemical Bldg., will receive bids for a power plant to include 2 large electric elevators, new generators, engine, pump, etc., for the Kennett Building, B'way. and Locust St.

Okla., Miami—T. L. Green, Consult. Engr., Miami, would like to receive catalogs and prices on oil and gas engines, pumps, motors, compressors, air receivers and other air lift equipment, motors, starters, generators, panel boards and other electric equipment necessary to the installation of electric light and pumping plants.

Cal., Los Angeles—The Anheuser-Busch Co., 9th and Pestalozzi St., St. Louis, Mo., plans to convert its bottling plant here into an ice factory and cold storage plant and build an ice cream factory adjoining same. G. E. Wells, Engr.

Ont., Barry Sound—The citizens plan to vote on $100,000 by-law June 21 for the construction of a power plant. R. J. Hall, Mayor.

CONTRACTS AWARDED

Mass., Campello—A. E. Kieth Co., Station St., Brockton, has awarded the contract for the construction of a 2 story, 60 x 70 ft. power house here, to Westcott & Mapes, 207 Orange St., New Haven. Estimated cost, $100,000.

Conn., Bridgeport—The Baptist Christian Union, Inc., 886 Main St., has awarded the contract for installing a heating plant in the 4 story, 80 x 102 ft. home on Main and Thomas St., to N. P. Kirk Co., 749 Main St. Noted Jan. 7.

Conn., Bridgeport—The Home Brewing Co., 226 Hallam St., has awarded the contract for the construction of a 1 story, 150 x 150 ft. artificial ice plant, to the Schwarz Bros. Co., 95 River St. Estimated cost, $200,000.

N. Y., Brooklyn—R. Gair Co., 50 Washington St., has awarded the contract for the construction of an addition to its boiler house on Plymouth St., to the Turner Construction Co., 244 Madison Ave., New York City.

N. Y., New York—A. J. Schwartzler, 369 East 167th St., will build a 2 story, 122 x 190 ft. ice plant on Fordham Rd. and Cedar Ave. Estimated cost, $45,000. Work will be done by day labor.

Fla., Pensacola—The Bureau of Yards & Docks, Navy Department, Washington, D. C., has awarded the contract for installing electric equipment in the central power plant here, to the Carroll Electric Co., 714 12th St., Washington, D. C. (150 days.) Noted Feb. 18.

Ohio, Bryan—The Trustees of Public Affairs has awarded the contract for the construction of a 1,000,000 gal. concrete reservoir and pump house, to the Toledo Residence Construction Co., 322 Nasby Bldg., Toledo. Estimated cost, $23,700.

Mich., Detroit—The Detroit Edison Co., David Whitney Bldg., will build a 55 mi. transmission line between here and Port Huron. Work involves 60 ft. poles set 40 to the mile, supporting copper cable transmitting 66,000 volts. Work will be done by day labor.

Ill., Chicago—Morris & Co., Union Stock Yards, has awarded the contract for the construction of a 9 story, 150 x 350 ft. cold storage warehouse on 44th and Loomis St., to R. C. Wieboldt, 1534 West Van Buren St. Estimated cost, $1,000,000.

Mo., St. Joseph—Swift & Co., Union Stock Yards, Chicago, Ill., has awarded the contract for the construction of a 2 story, 42 x 110 ft. addition to its cold storage plant on Packers Ave., to the Lehr Construction Co., 1712 Frederick Ave. Estimated cost, $30,500.

Tex., Goose Creek—The Humble Oil & Refining Co., Goggan Bldg., Houston, has awarded the contract for the construction of a group of buildings here, to consist of boiler shops, power and pump houses, ice plant and repair shops, etc., to the Turner Construction Co., 244 Madison Ave., New York City.

Read the

SEARCHLIGHT SECTION

The "Opportunity" advertising of the Power Plant Field

See pages 55 to 67